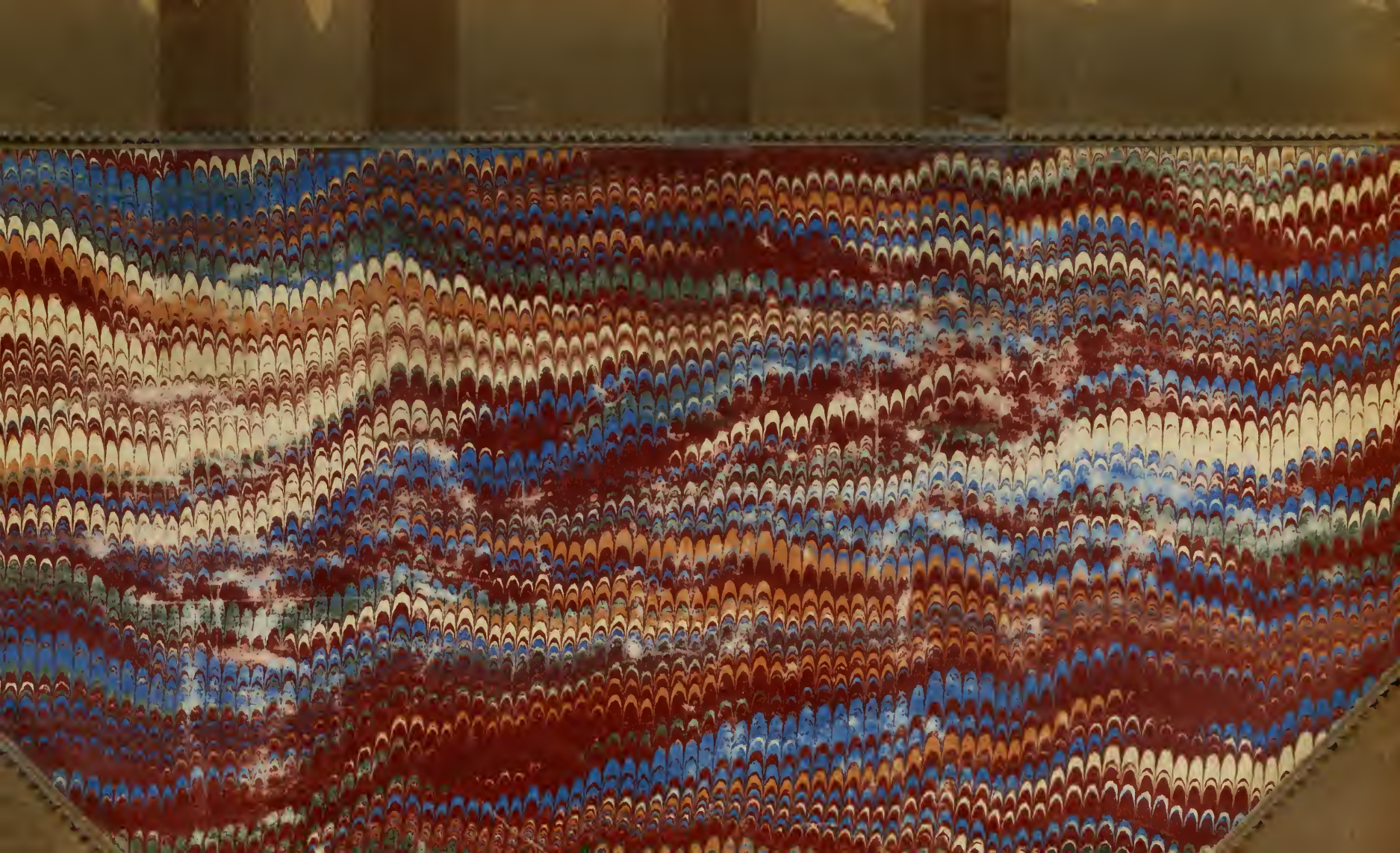

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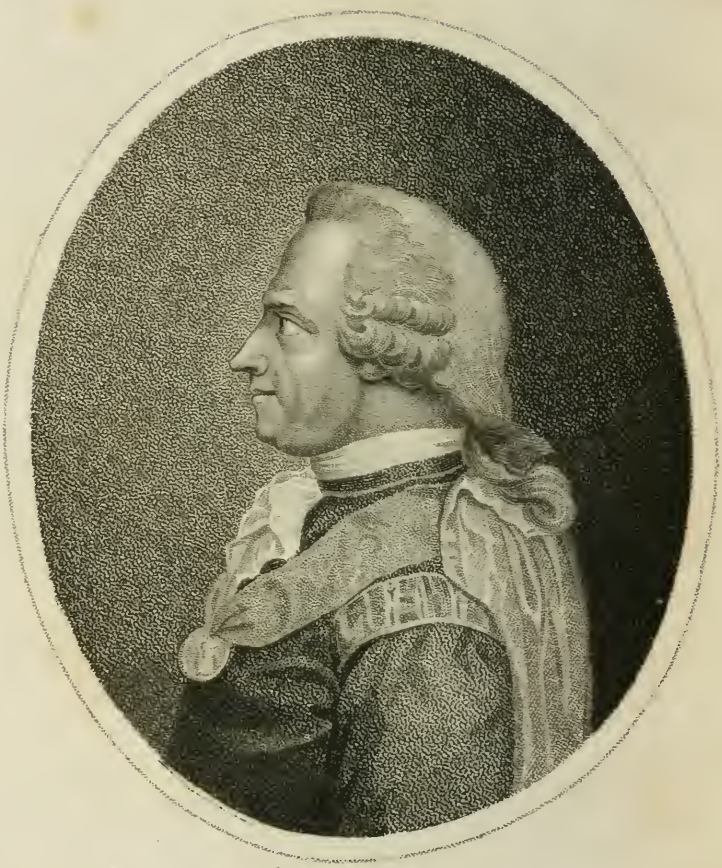

K. Mackenzie sc.

T. Bergman

Professor of Chemistry at Upsal.

Published May 1st 1801.

THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

VOL. III.

LONDON:

Printed for ALEXANDER TILLOCH; and ſold by Meſſrs. RICHARDSON, Cornhill; CADELL and DAVIES, Strand; DEBRETT, Piccadilly; MURRAY and HIGHLEY, No. 32, Fleet-ſtreet; SYMONDS, Paternoſter-Row; BELL, No. 148, Oxford-ſtreet; VERNOR and HOOD, Poultry; HARDING, No. 36, St. James's-ſtreet; WESTLEY, No. 159, Strand; J. REMNANT, High-ſtreet, Bloomſbury; and W. REMNANT, Hamburgh.

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THE

THE

PHILOSOPHICAL MAGAZINE.

FEBRUARY 1799.

I. *Deſcription of the Volcano in the Iſland of St. Lucia. By* M. CASSAN. *From* New Tranſactions of the Swediſh Academy of Sciences, *Vol. XI.*

MORE volcanoes are to be found in the Weſt India iſlands than in any other part of the globe; and from the frequency of earthquakes, the abundance of hot ſprings, &c. in theſe iſlands, there is reaſon to conclude that thoſe ſubſtances which are the cauſe of them ſtill exiſt. On account of the great quantity of ſulphur produced by the mountain where this crater is ſituated, the name of *la Souffriere* has been given to it and to the whole adjacent diſtrict. The mountain itſelf forms a part of a high ridge, which runs acroſs the whole iſland from north-eaſt to ſouth-weſt, and encloſes the crater like a baſon, which can be reached without great difficulty. Thoſe who viſit it muſt put on thick-ſoaled boots, as the earth, before they have got to the diſtance of two miles from the town, becomes exceedingly hot; and they muſt carry nothing of metal with them, and particularly ſilver, becauſe their ſplendor is deſtroyed by the vapour. The ſulphuriſed hydrogenous ſmell, which ſtill increaſes,

begins at the diſtance of little more than half a mile from the town. But however ſtrong this ſmell may be, it ſeems not to be prejudicial, for the inhabitants in the neighbourhood enjoy the beſt health and attain to a conſiderable age. Though this diſtrict is mountainous and expoſed to inundations, it is very fruitful: its ſugar canes produce the richeſt ſugar, as the diſtricts around Etna and Veſuvius produce the moſt celebrated wine. The nearer you approach the crater, the more numerous you find the volcanic productions. You paſs over various rivulets, the water of which has a ſulphureous ſmell, and the ſcum ſeems to contain ſaline and ochery matter. You ſoon after arrive at the ſide of the mountain which riſes over the volcano towards the ſouth-weſt. The road lies acroſs the declivity of the mountain, which is exceedingly ſteep; ſo that the traveller on one ſide ſees a terrible, almoſt perpendicular, abyſs filled with abundance of vapour from boiling water by which he is ſurrounded, and as it were enveloped: on the other ſide he is encloſed by a high ſteep rock, yet one can ride without danger to that part of the mountain which encloſes the volcano on the eaſt ſide; but when you arrive there, you muſt procure a guide, and deſcend the mountain, by a very ſteep path, between low thick bruſh-wood. Throughout the whole way you muſt beat on both ſides with a ſtick, in order to guard againſt being bit by ſnakes. Scarcely have you reached the bottom of the mountain when you find the heat of the atmoſphere conſiderably increaſed, and the earth hot under the feet. The ſulphureous vapours which here ſurround the body ſoon occaſion an abundant perſpiration, and the ſulphuriſed hydrogenous ſmell is ſo powerful as to oblige many perſons to return. The valley which encloſes the volcano is about ſixty fathoms long, fifty broad, and lies ſixty fathoms higher than the level of the ſea. It appears as if the volcano had long ago formed the hollow, in which it is ſituated, by ſplitting the mountain that ſurrounds the cavity, and by its eruption caſting to a diſtance on one ſide thoſe parts which covered

the

the centre or focus. In looking down into the crater great care muſt be taken that the ground, which rings below the feet, does not ſink, which would expoſe the legs to the danger of being burnt. For this reaſon it is uſual to ſend a guide before to point out the places that are ſecure, eſpecially when the weather is changeable; for people may then be ſpeedily ſurrounded by vapours that almoſt obſcure the ſun. It has alſo been remarked, that during rain the vapours are more abundant and thicker than at other times. It is difficult to ſay with any certainty what is the nature of the ſoil to be paſſed over in order to enter the crater; but it ſeems to conſiſt of decompoſed remains, or the ſcoriæ of different minerals, and particularly of pyrites, which however have changed their nature. As you advance farther, the ſurface of the earth appears more and more covered with ſulphur, and you find a number of ſmall ſpiracles, from which ariſes a burning vapour, and which are covered on the ſides with ſublimed ſulphur that has a very beautiful appearance. All theſe apertures may be conſidered as ſo many apparatuſes for diſtillation, which nature has prepared, in order to purify the ſulphur. If you ſtrike your ſtick againſt the ground in this ſpot, it occaſions a vent of that kind, through which the vapour iſſues with a ſtrong hiſſing noiſe, and ſo hot that it raiſes the thermometer ten degrees above the boiling point. From theſe apertures, whether the work of nature or of art, it appears that the whole ſurrounding diſtrict below the ſurface is filled with boiling water; but this water does not proceed from rain or from ſprings in the crater, but, in all probability, from the mountain which riſes above the volcano on the eaſtern ſide. This is the more credible, as the top of this mountain ends in a kind of funnel, which is of great width, and conſiſts of very marſhy ground. Several ſmall ſtreams iſſue from it alſo at different heights, and, after traverſing the ſurface of the crater, purſue their way through the valley and diſcharge themſelves into the ſea. The water of all theſe ſtreams is exceedingly warm, and is

covered with a multitude of air bubbles, ſo that it ſparkles like champagne. Theſe bubbles exhibit all the phenomena of oxygen gas, which probably is diſengaged from oxydes of various kinds with which it was combined in the earth. What among the phenomena of the crater excites moſt wonder are, twenty-two large baſons, full of boiling water; ſome of which are twenty feet in diameter, and which may be conſidered as monſtrous cauldrons placed over the moſt violent fire. The ebullition is ſo ſtrong that water bubbles of four or five feet in height are thrown up, which raiſe the thermometer far above the boiling point; but this however is the caſe only in thoſe where the water is from one to two feet in depth, though the depth in general amounts to eight or ten feet. You may walk round the edge of them without any danger, and contemplate at leiſure this aſtoniſhing quantity of boiling water. It is of a black colour, oily, covered with ſcum at the edges, and diffuſes a vapour which obſcures the atmoſphere. From this ebullition and high ſtate of the thermometer, we might be induced to believe, that there is a great quantity of heat in theſe baſons; but if you put your hand into the water, you find the heat leſs than that of boiling water. The ebullition alſo may proceed only from the vapours which riſe from the bottom of the excavations with ſo much ſtrength that they give the water a boiling movement; and, in the like manner, the riſing of the thermometer ought to be aſcribed to theſe vapours alſo. The ſurface of the ground is of a pale yellow colour, and beſprinkled with a multitude of ſmall ſhining cryſtals, for the moſt part cryſtals of ſulphur. The upper part of the crater, towards the ſouth-eaſt, riſes exceedingly ſteep, and is covered with a great number of other cryſtals lying in a kind of earth, which is partly calcareous, and partly of an unctuous nature like clay. Among theſe cryſtals there are ſome ſhaped like flat needles, and which are real cryſtals of ſulphat of lime. Others exhibit all the properties of ſulphat of alumine; others appear like ſulphat of iron, greatly ſuperſaturated with the acid;

and

and others like ferruginous pyrites covered with an efflorescence by the action of the atmosphere and water. The above-mentioned substances must be considered as the principal causes of the violent commotions which appear in this crater. They are supplied from a large stratum of pyrites; and from the violence of the combustion, we may conjecture that it must be very deep. It is probable also that this stratum is of considerable extent, for very hot springs are found at the distance of a mile both to the north and south of the volcano. Such substances accumulated in different parts of the earth, when accidentally combined with other substances, such as air, water, and inflammable bodies, produce earthquakes and other convulsions of nature. Though the internal re-action of these substances on one another seems to threaten danger, it however occasions no damage to the colony, because they have immediate communication with the atmosphere, and the whole soil is penetrated by water so that it cannot take fire: neither are coal, bitumen, or such inflammable bodies found in the neighbourhood.

II. *Account of the Method of Catching Wild Elephants at Tipura* in the East Indies. By* JOHN CORSE, Esq. *From* The Asiatic Researches.

IN the month of November, when the weather has become cool, and the swamps and marshes, formed by the rains in the five preceding months, are lessened, and some of them dried up, a number of people are employed to go in quest of elephants.

At this season the males come from the recesses of the forest into the borders and outskirts thereof, whence they

* The ancient name of the province was *Tripura*, or *with three towns*, which has been corrupted into *Tipra* or *Tipara*.

make nocturnal excurſions into the plains in ſearch of food, and where they often deſtroy the labours of the huſbandman, by devouring and trampling down the rice, ſugar canes, &c. that they meet with. A herd or drove of elephants, from what I can learn, has never been ſeen to leave the woods: ſome of the largeſt males often ſtray to a conſiderable diſtance; but the young ones always remain in the foreſt under the protection of the Palmai, or leader of the herd, and of the larger elephants. The Goondahs, or large males, come out ſingly, or in ſmall parties, ſometimes in the morning, but commonly in the evening; and they continue to feed all night upon the long graſs, that grows amidſt the ſwamps and marſhes, and of which they are extremely fond. As often, however, as they have an opportunity, they commit depredations on the rice fields, ſugar canes, and plantain trees that are near, which oblige the farmers to keep regular watch, under a ſmall cover, erected on the tops of a few long bamboos, about 14 feet from the ground: and this precaution is neceſſary to protect them from the tigers, with which this province abounds. From this lofty ſtation the alarm is ſoon communicated from one watchman to another, and to the neighbouring villages, by means of a rattle with which each is provided. With their ſhouts and cries, and noiſe of the rattles, the elephants are generally ſcared and retire. It ſometimes, however, happens, that the males advance even to the villages, overturn the houſes, and kill thoſe who unfortunately come in their way, unleſs they have had time to light a number of fires: this element ſeems to be the moſt dreaded by wild elephants, and a few lighted wiſps of ſtraw or dried graſs ſeldom fail to ſtop their progreſs. To ſecure one of the males, a very different method is employed from that which is taken to ſecure a herd: the former is taken by Koomkees, or female elephants trained for the purpoſe, whereas the latter is driven into a ſtrong encloſure called a Keddah.

As

As the hunters know the places where the elephants come out to feed, they advance towards them in the evening with four Koomkees, which is the number of which each hunting party conſiſts: when the nights are dark, and theſe are the moſt favourable for their purpoſe, the male elephants are diſcovered by the noiſe they make in cleaning their food, by whiſking and ſtriking it againſt their forelegs, and by moonlight they can ſee them diſtinctly at ſome diſtance.

As ſoon as they have determined on the Goondah they mean to ſecure, three of the Koomkees are conducted ſilently and ſlowly by their Mahotes (drivers) at a moderate diſtance from each other, near to the place where he is feeding; the Koomkees advance very cautiouſly, feeding as they go along, and appear like wild elephants, that have ſtrayed from the jungle. When the male perceives them approaching, if he takes the alarm and is viciouſly inclined, he beats the ground with his trunk and makes a noiſe, ſhowing evident marks of his diſpleaſure, and that he will not allow them to approach nearer; and if they perſiſt, he will immediately attack and gore them with his tuſks; for which reaſon they take care to retreat in good time. But ſhould he be amorouſly diſpoſed, which is generally the caſe, (as theſe males are ſuppoſed to be driven from the herd at a particular period by their ſeniors, to prevent their having connection with the females of that herd,) he allows the females to approach, and ſometimes even advances to meet them.

When, from theſe appearances, the Mahotes judge that he will become their prize, they conduct two of the females, one on each ſide cloſe to him, and make them advance backwards, and preſs gently with their poſteriors againſt his neck and ſhoulders: the third female then comes up and places herſelf directly acroſs his tail; in this ſituation, ſo far from ſuſpecting any deſign againſt his liberty, he begins to toy with the females and careſs them with his trunk. While thus engaged, the fourth female is brought near, with ropes and proper aſſiſtants, who immediately get under the belly of the

third female, and put a ſlight cord (the Chilkah *) round his hind legs: ſhould he move, it is eaſily broken; in which caſe, if he takes no notice of this ſlight confinement, nor appears ſuſpicious of what was going forward, the hunters then proceed to tie his legs with a ſtrong cord (called Bundah †), which is paſſed alternately, by means of a forked ſtick and a kind of hook, from one leg to the other, forming the figure of 8; and as theſe ropes are ſhort, for the convenience of being more readily put around his legs, 6 or 8 are generally employed, and they are made faſt by another cord (the Daugbearee ‡), which is paſſed a few turns perpendicularly between his legs, where the folds of the Bundahs interſect each other. A ſtrong cable (the Phand §) with a running nooſe, 60 cubits long, is next put round each hind leg immediately above the Bundahs, and again above them, 6 or 8 additional Bundahs, according to the ſize of the elephant, are made faſt, in the ſame manner as the others were: the putting on theſe ropes generally takes up about 20 minutes, during which the utmoſt ſilence is obſerved, and the Mahotes, who keep flat upon the necks of the females, are covered with dark coloured cloths, which ſerve to keep them warm, and at the ſame time do not attract the notice of the elephant. While the people are buſily employed in tying

* Chilkă—is a very ſlight ſoft cord, which the hunters at firſt put around the hind-legs of a Goondah, before they begin to tie him: this is not uſed for Keddah elephants.

† Bundah—a middle-ſized cord, ſix or eight cubits long, which is put round either the hind or fore legs of elephants, in order to ſecure them. From ten to twenty are employed.

‡ Daugbearee—is generally a continuation of every ſecond Bundah that is put on, a few turns of which are paſſed round, where the folds of the Bundahs interſect each other, in order to faſten and keep them firm. When the Bundah is not long enough, another cord is made uſe of.

§ Phand—is a cable nearly the ſame ſize as the Dool, the nooſe of which is put round each leg of the Goondahs, and then it is tied to trees or ſtakes. The Phands, uſed for the Keddah elephants, are only about thirty cubits long.

the legs of the Goondah, he careſſes ſometimes one, and ſometimes another, of the ſeducers (Kootne), examining their beauties and toying with different parts, by which his deſires are excited and his attention diverted from the hunters, and in theſe amorous dalliances he is indulged by the females. But if his paſſions ſhould be ſo rouſed, before his legs are properly ſecured, as to induce him to attempt leaping on one of the females, the Mahote, to inſure his own ſafety and prevent him gratifying his deſires any further, makes the female run away, and at the ſame time, by raiſing his voice and making a noiſe, he deters the Goondah from purſuing: this however happens very ſeldom, for he is ſo ſecured by the preſſure of a Koomkee on each ſide and one behind, that he can hardly turn himſelf, or ſee any of the people, who always keep ſnug under the belly of the third female, that ſtands acroſs his tail, and which ſerves both to keep him ſteady and to prevent his kicking any of the people who are employed in ſecuring him; but in general he is ſo much taken up with his decoyers, as to attend very little to any thing elſe. In caſe of accidents, however, ſhould the Goondah break looſe, the people upon the firſt alarm can always mount on the backs of the tame elephants, by a rope that hangs ready for the purpoſe, and thus get out of his reach. When his hind legs are properly ſecured, they leave him to himſelf, and retire to a ſmall diſtance: as ſoon as the Koomkees leave him, he attempts to follow, but finding his legs tied, he is rouſed to a proper ſenſe of his ſituation, and retreats towards the jungle; the Mahotes follow at a moderate diſtance from him, on the tame elephants, accompanied by a number of people that had been previouſly ſent for, and who, as ſoon as the Goondah paſſes near a ſtout tree, make a few turns of the Phands, or long cables that are trailing behind him, around its trunk: his progreſs being thus ſtopt, he becomes furious, and exerts his utmoſt force to diſengage himſelf; nor will he then allow any of the Koomkees to come near him, but is outrageous for ſome time,

time, falling down and goring the earth with his tuſks. If by theſe exertions the Phands are once broken, which ſometimes is effected, and he eſcapes into the thick jungle, the Mahotes dare not advance for fear of the other wild elephants, and are therefore obliged to leave him to his fate; and in this hampered ſituation, it is ſaid, he is even ungeneroufly attacked by the other wild elephants. As the cables are very ſtrong and ſeldom give way, when he has exhauſted himſelf by his exertions, the Koomkees are again brought near and take their former poſitions, viz. one on each ſide and the other behind. After getting him nearer the tree, the people carry the ends of the long cables around his legs, then back and about the trunk of the tree, making, if they can, two or three turns, ſo as to prevent even the poſſibility of his eſcape. It would be almoſt impoſſible to ſecure an elephant in any other manner, as he would tear up any ſtake that could at the time be driven into the ground, and even the noiſe of doing it would frighten the elephant: for theſe reaſons, as far as I can learn, nothing leſs than a ſtrong tree is ever truſted to by the hunters. For ſtill farther ſecurity, as well as to confine him from moving to either ſide, his fore-legs are tied exactly in the ſame manner as the hind-legs were, and the Phands are made faſt, one on each ſide, to trees or ſtakes driven deep into the earth. During the proceſs of tying both the hind and fore-legs, the fourth Koomkee gives aſſiſtance where neceſſary, and the people employed cautiouſly avoid going within reach of his trunk; and when he attempts to ſeize them, they retreat to the oppoſite ſide of the Koomkees, and get on them, if neceſſary, by means of the rope above mentioned, which hangs ready for them to lay hold of. Although by theſe means he is perfectly ſecured and cannot eſcape, yet as it would be both unſafe and inconvenient to allow him to remain in the verge of the jungle, a number of additional ropes are afterwards put on, as ſhall be mentioned, for the purpoſe of conducting him to a proper ſtation. When the Goondah has

become more ſettled, and eat a little food, with which he is ſupplied, as ſoon as he is taken, the Koomkees are again brought near, and a ſtrong rope (Pharah *) is then put twice round his body, cloſe to his fore-legs like a girth, and tied behind his ſhoulder; then the long end is carried back cloſe to his rump and there faſtened, after a couple of turns more have been made round his body. Another cord is next faſtened to the Pharah, and from thence carried under his tail like a crupper (Dooblah †), and brought forward and faſtened by a turn or two, to each of the Pharahs, or girths, by which the whole is connected, and each turn of theſe cords ſerves to keep the reſt in their places. After this a ſtrong rope (the Tooman ‡) is put round his buttocks and made faſt on each ſide to the girth and crupper, ſo as to confine the motion of his thighs and prevent his taking a full ſtep. Theſe ſmaller ropes being properly adjuſted, a couple of large cables (the Dools §) with running nooſes are put around his neck, and after being drawn moderately tight, the nooſes are ſecured from running cloſer, and then tied to the ropes on each ſide forming the girth and crupper already mentioned; and thus all theſe ropes are connected and kept in their pro-

* Phárah—a rope that is put round the body of an elephant, like a girth, and to which the Dooblah and Dools are connected.

† Dooblah—is that rope which is made faſt on one ſide to the aftermoſt Pharah, then carried under the tail and faſtened to both the Pharahs on the oppoſite ſide, ſo as to anſwer the purpoſe of a crupper, and to keep the Pharahs in their places.

‡ Tooman—is the rope that is paſſed round the buttocks of an elephant, and prevents his ſtepping out freely: it is faſtened to the girth and crupper, that it may not ſlip down.

§ Dool—is a large cable, about ſixty cubits long, with a running nooſe. Two of them are put round the neck of the elephant, and faſtened to the foremoſt Pharah or girth, one on each ſide, in ſuch a manner as to prevent the nooſes from being drawn too tight or coming too far forward: and this is effectually done by the Dooblah; for, whenever the elephant draws back, the Dools pull the crupper forward, which muſt gall him very much, and prevent him from uſing all the force he might otherwiſe exert, in order to free himſelf.

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per places, without any risk of the nooses of the Dools becoming tight, so as to endanger the life of the elephant in his exertions to free himself. The ends of these cables are made fast to two Koomkees, one on each side of the Goondah, by a couple of turns round the belly, close to the shoulder, like a girth, where a turn is made, and it is then carried across the chest and fastened to the girth on the opposite side. Every thing being now ready, and a passage cleared from the jungle, all the ropes are taken from his legs, and only the Tooman remains round his buttocks to confine the motion of his hind legs: the Koomkees pull him forward by the Dools, and the people from behind urge him on. Instead of advancing in the direction they wish, he attempts to retreat farther into the jungle; he exerts all his force, falls down and tears the earth with his tusks, screaming and groaning, and by his violent exertions often hurts and bruises himself very much; and instances happen of their surviving these violent exertions only a few hours, or at most a few days. In general, however, they soon become reconciled to their fate, will eat immediately after they are taken, and, if necessary, may be conducted from the verge of the jungle as soon as a passage is cleared. When the elephant is brought to his proper station and made fast, he is treated with a mixture of severity and gentleness, and in a few months (if docile) he becomes tractable, and appears perfectly reconciled to his fate. It appears somewhat extraordinary, that though the Goondah uses his utmost force to disengage himself when taken, and would kill any person coming within his reach, yet he never or at least seldom attempts to hurt the females that have ensnared him, but on the contrary seems pleased (as often as they are brought near, in order to adjust his harnessing, or move and slacken those ropes which gall him), soothed and comforted by them, as it were, for the loss of his liberty. All the elephants, soon after they are taken, are led out occasionally for exercise by the Koomkees, which attend for that purpose.

[To be concluded in our next.

III. *On*

III. *On the Materials uſed for Manufacturing Caſt Iron, By Mr.* DAVID MUSHET *of the Clyde Iron Works. Communicated by the Author.*

THE operation of extracting crude or caſt iron from the ores is one of the leaſt complicated proceſſes in the art of fuſion. Simply the materials are thrown into the furnace, *ſtratum ſuper ſtratum*, and crude-iron is the reſult. Experience no doubt at firſt tutored the manufacturer, and taught him by repeated leſſons the juſt proportions neceſſary for the production of certain qualities of iron.

The materials uſed for the manufacturing of crude-iron in this iſland, before the application of pit-coal, preſent themſelves in the following order: Charcoal of wood of different kinds, primary ores of iron, with various proportions of argillaceous or calcareous iron ſtones. Since, charcoal or coaks made from pit-coal, argillaceous ores of iron, with ſmall proportions of Lancaſhire and Cumberland ores. Calcareous ſtones for a flux or ſolvent.

In ſpeaking of ſome of theſe ſeparately, I ſhall not confine my obſervations to their application to uſe in the iſland of Britain alone; but treat of them as connected with the operation of fuſion for the production of caſt-iron in general.

Charred wood is almoſt univerſally uſed throughout the Continent, as fuel for the production of caſt-iron. From its great abundance in the northern countries, the diſcovery of pit-coal would be deemed of little advantage for many years to come *. The extenſive woods in Siberia and Sweden afford a conſtant ſupply of fuel to the numerous iron works in thoſe countries. The neceſſary regulations which the reſpective governments of each country have thought proper to enact, will in all probability preſerve, during their exiſtence, the neceſſary ſupply of fuel for the

* Pit-coal has been diſcovered in Siberia of various qualities and in great abundance, fit for the ſame purpoſes to which it is applied in this country.

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manufacturers*. If the woods receive neceſſary care and attention after the firſt cutting, they will replace themſelves at periods from 15 to 18 years. The charcoal uſed in Siberia is all made from the pine and larch, the country affording no other varieties of timber. In Sweden the manufacturers are ſupplied with a conſiderable proportion of harder woods, which is greatly in favour of the manufacture.

It has been already noticed, in a former paper, that the fuel uſed in Britain at an early period, and ſo far down as the beginning of the preſent century, chiefly conſiſted of wood. The kinds of wood uſed for this purpoſe were various; but char of hard wood, ſuch as oak, birch, aſh, &c. &c. was always preferred to that made from pine, holly, ſallow, &c. &c. At the ſmall remaining number of charcoal furnaces now in this country, the oak has ſtill the undoubted preference. Its firmneſs and continuity enable it in the blaſt furnace to ſupport and convey principle to the iron contained in a larger portion of ore, than charcoal made from ſofter wood. The ſame properties alſo enable it for a time to ſuſtain a heavier preſſure of air from the diſcharging pipe: this facilitates the reduction of the whole, and greatly augments the weekly produce in iron. The mode of preparing charcoal of wood for the blaſt-furnace, though extremely ſimple, is yet capable of being greatly miſunderſtood, ſo as to occaſion a conſiderable waſte of wood in the proceſs. The following is the detail of an operation which I have ſeen ſucceſsfully tried, and which was productive of excellent charcoal. It is the ſame I believe as is followed at the two charcoal furnaces in Argyleſhire.

Firſt of all, a plot of ground is raiſed a little higher than

* In Sweden there is a law reſtricting the manufacturers of iron to a certain annual produce; and this quantity is always in proportion to the ground attached to the work. In this manner the wood is enabled to replace itſelf at certain intervals; and each work is inſured of an annual though moderate ſupply. The more extenſive and unpeopled tracts of Siberia, render ſuch exactitude in the execution of the laws leſs neceſſary.

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the ſurrounding ſurface: this is made ſlightly convex. The burner commences by placing in the centre a circle of ſticks, tranſverſely inclining, and croſſing each other near their tops. Around theſe are built ſucceſſive circles of wood of various ſizes, from 1 to 10 inches diameter; but care is always taken to place thoſe of ſimilar diameters in the ſame circle. A round of beams, of the largeſt nature, is immediately followed by one ſo much ſmaller as to fill up the interſtices between the larger diameters, that no more air may be admitted than is neceſſary to excite gradual combuſtion. Theſe are again followed by pieces of an increaſing diameter. This mode of ranging the large and ſmall ſizes is continued till ſuch time as the pile is deemed ſufficiently large. The total width may then meaſure from 20 to 30 feet. The laſt layer is commonly compoſed of ſmall bruſh-wood. The whole is then covered with turf, the graſſy ſide towards the wood; a coating of earth is then applied all round the bottom of the pile, and firmly beat to prevent the unneceſſary admiſſion of air. A ſmall funnel, or opening on the top, is preſerved by the tranſverſe poſition of the firſt layer of wood; this is generally about 18 inches deep, into which the burning fuel is introduced. Combuſtion is in this manner firſt conveyed to the top of the pile, and is continued by feeding the ſmall craters with pieces of wood for 4 or 5 days. When the interior part of the fire next the top is deemed ſufficiently kindled and ſpread over the whole diameter, a row of holes is opened a few inches below, each about two inches diameter. The hole at the top is then entirely ſhut up, and the fire, now completely ſpread, ſlowly deſcends to where the air is admitted by means of the ſmall apertures. When this is obſerved by the burner, which is known by the diſappearance of ſmoke and vapour, they are immediately ſhut up, and a ſecond row opened 6 or 8 inches under the firſt. In this manner the fire is conducted to the foundation of the pile, and the whole maſs expoſed to proper combuſtion. The intention of the operation is to bring the whole pile to a ſtate of complete ignition, but in ſuch a manner

manner that no greater a portion of it may undergo combuſtion than is neceſſary to produce that effect. Hence the neceſſity for guarding againſt too free an acceſs of air during the proceſs. As ſoon as the operation is ended, which may laſt for 10 or 14 days, the whole is more cloſely covered up, and kept ſo till ſuch time as the char is deemed ſufficiently cool to be fit for drawing: it is then ſeparated from the earth, and carried away in bags or in waggons. Thoſe pieces of wood not ſufficiently charred are by the workmen called *brands*, and are commonly uſed for fuel to the next fire.

The loſs of weight in charring wood is inconceivably great. In the large way it is almoſt impoſſible to aſcertain it to any degree of exactneſs. The qualities of wood are ſo various, and the tendency which ſome have beyond others of parting with their juices, even when expoſed to the ſame temperature, render it at beſt but a matter of dubiety. I ſhall however inſert a few which I have charred in the ſmall way, and the reſults obtained from them; before weighing they were all expoſed to the ſame temperature for a conſiderable time, and thoroughly dried.

It is however worthy of remark, that the produce in charcoal in the ſmall way, does not give an invariable ſtandard whereby to judge of that obtained on a large ſcale, where ignition is cauſed by the admiſſion of external air into contact with the wood. In the large way the quantity of char afforded will depend more upon the hardneſs and compactneſs of the texture of wood, and the ſkill of the workman, than on the quantity of carbon it contains. In the following tables I have ſimply expreſſed the exiſtence of the alkaline principle, in the various aſhes obtained from the combuſtion of 1 pound of wood avoirdupoiſe weight: this may be of uſe to thoſe who wiſh to make experiments upon the formation of pot-aſh. It will alſo be obſerved, that there are ſome woods that yield a much larger proportion of carbon than oak: theſe, however, are either too ſcarce or too valuable to be applied to the manufacturing of iron in this country.

TABLE

TABLE of the component Parts of 1 Engliſh Pound Avoirdupoiſe, or 7000 Troy Grains of the following Varieties of Wood.

	Water, Hydr. gas, Carb. acid.	Carbon	Aſhes	Colour and Degree of Saturation of the Alkaline Principle.
Oak - -	5382,6	1587,8	29,6	Grey, ſharply alkaline.
Aſh - -	5638,2	1258,0	53,8	Whitiſh blue, do.
Birch - -	5650,2	1224,4	125,4	Brownſh red, do.
Norway Pine	5630,9	1344,3	24,8	Brown, not in the leaſt alkaline.
Mahogany -	5147,00	1784,2	68,6	Grey, ſharply alkaline.
Sycamore -	5544,00	1381,4	74,6	Pure white, weakly do.
Holly - -	5524,4	1394,3	81,3	Do. ſharply do.
Scotch Pine -	5816,7	1151,9	31,4	Brown, perceptibly do.
Beech - -	5537,3	1395,9	66,8	Greyiſh white, ſharply do.
Elm - -	5576,6	1370,2	53,2	Grey, partially do.
Walnut - -	5496,5	1446,4	57,1	Pure white, light as down, weakly do.
Americ. Mapple	5553,2	1393,1	53,7	Dark grey, ſharply do.
Do. Black Beech	5425,9	1301,8	72,3	Brown, do.
Laburnum -	5196,4	1721,0	82,6	White and grey, partially alkaline.
Lignum Vitæ	5083,00	1882,0	35,0	Grey, ſharply do.
Sallow - -	5626,00	1294,8	79,2	Light grey, do.
Cheſnut - -	5341,3	1629,6	29,1	Grey, do.

Parts in 100.

	Water, Hydr. gas, Carb. acid.	Carbon	Aſhes	Colour, Nature, Compactneſs of the Charcoal.
Oak - -	76,895	22,682	,425	Black, cloſe and very firm.
Aſh - -	81,260	17,972	,768	Shining black, ſpongy, moderately firm.
Birch - -	80,717	17,491	1,792	Velvet black, bulky and do.
Norway Pine	80,441	19,204	,355	Shining black, bulky and very ſoft.
Mahogany -	73,528	25,492	,980	Tinged with brown, ſpongy, and firm.
Sycamore -	79,200	19,734	1,066	Fine black, bulky and moderately firm.
Holly - -	78,920	19,918	1,162	Dull black, looſe and bulky.
Scotch Pine -	83,095	16,456	,449	Tinged with brown, bulky but pretty firm.
Beech - -	79,104	19,941	,955	Dull black, ſpongy, but very firm.
Elm - -	79,655	19,574	,761	Fine black, moderately firm.
Walnut - -	78,521	20,663	,816	Dull black, texture cloſe, body firm.
American Mapple	79,331	19,901	,768	Dull black, texture cloſe, moderately do.
Do. Black Beech	77,512	21,455	,033	Fine black, compact and remarkably hard.
Laburnum -	74,234	24,586	1,180	Velvet black, do.
Lignum Vitæ	72,643	26,857	,500	Greyiſh. reſembles pit coal, coaks, do.
Sallow - -	80,371	18,497	1,132	Velvet black, bulky, looſe and ſoft.
Cheſnut - -	76,304	23,280	,416	Gloſſy black, compact and firm.

The advantages that charcoal poſſeſſes, beyond thoſe of pit-coal, for the manufacturing of crude iron, are derived from the purity of its component parts, and the ſuperior quantity of unalloyed carbon it affords to the iron. This principle is preſented to the metal free from the combination of clay, lime, ſand, and ſulphur; with which pit-coal frequently abounds. A determinate quantity of charcoal by meaſure, will ſmelt and convey principle to three times the quantity of iron that can be done by the ſame meaſure of pit-coal coaks. Its greateſt and moſt uſeful property, however, ſeems to be developed in the refinery fire, and ſimilar bar-iron operations; where it manifeſts in the moſt evident manner its ſuperiority over pit-coal, by ſhortening the tedious proceſſes of the forge, diminiſhing the waſte, and affording a much ſuperior quality of iron for all the purpoſes of ſubſequent manufacture.

Pit Coal.

No ſooner had the conſequences of the general diminution of wood, for the purpoſe of making charcoal, been felt by individuals, whoſe intereſt it was to ſupport the fabrication of iron, than their violent prejudices were laid aſide againſt the uſe of pit-coal, and this mineral combuſtible ſubſtance was brought forward, and eſtabliſhed as the baſis of a profitable and uſeful manufacture.

* Pit-coal has hitherto been better known, and its uſefulneſs made more ſubſervient to the purpoſes of life and of manufacture in Britain, than in any other country. This valuable fuel is generally found in ſtrata of various dimenſions, and of various inclinations from the parallel of the horizon. It is alſo found, though ſeldom, in vertical maſſes irregularly diffuſed, and leſs extenſive than the former. Regular ſtrata widely extended are found from 2 to 10 feet in thickneſs; thoſe moſt commonly met with are from 3 to 6 feet*.

* There is at Dyſart in Fifeſhire a regular ſtratum of coal upwards of 24 feet thick, and is the thickeſt ever heard of in this country.

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The pit-coal in Scotland may be arranged under the following claſſes, of each of which there are many varieties: ſplint coal, free coal, and bituminous coal. To the former a juſt preference has always been given, for the ſuperior effects it produces in the blaſt-furnace. Free coal ſeems to partake of the nature of the ſplint and the bituminous coal, and is frequently found interſperſed with ſmall layers of ſplint. It ought therefore to be conſidered as the medium ſtate of the mineral. Under bituminous coal may be arranged the lighter varieties, known by the names of candle-coal, parrot-coal, &c. Theſe hitherto have been deemed unfit for the manufacturing of crude iron in any profitable ſhape.

As in this place I mean only to convey a juſt idea of the materials uſed in the ſmelting proceſs, I ſhall not enter into a comparative view of the relative effects which the various qualities of coal produce, when uſed in the ſmelting or caſting-furnace; but confine my deſcription to that quality which can be uſed for manufacturing crude iron to advantage. Of this kind there are two varieties; the pure ſplint and a mixture of ſplint and free coal, generally compoſed of alternate ſtrata of each. Both theſe poſſeſs their advantages derived from local conſtruction; the former being the moſt preferable, where a ſuperiority of mechanic power affords the furnace a heavy and unremitted ſupply of air. The latter will be found to poſſeſs equal advantages, where a deficiency of power in the air machine conveys to the furnace but a ſparing column of blaſt. The purer and the more approaching to ſplint is the coal, the more capable will it be of ſupporting unſhaken a current of highly compreſſed air, and of conveying the carbonaceous principle to the iron; which ſtamps its utility and value. On the contrary, the ſofter and leſs connected the coal, the leſs capable is it of reſiſting the force of the blaſt, and of ſupporting a certain proportion of ore till ſuch time as the metal which it contains imbibes the coally principle, ſo eſſential to its

exiſting as melting pig-iron; and which is always effected previous to ſeparation—of courſe before the mixtures ought to come in contact with the blaſt.

To theſe general data, the following quality of coal found in different places in England and Wales claims exception. This coal is compoſed of a very ſmall proportion of bitumen, and contains more carbon than any of the Scotch coals hitherto diſcovered. To the purity of the ſplint-coal it unites all the ſoftneſs and combuſtibility of wood. The effects produced by it in the blaſt-furnace, either as to quantity or quality of caſt-iron, far exceed any thing in the hiſtory of the manufacture of that metal with charcoal. At preſent there is one furnace in Wales that yields 60 tons of pig-iron upon an average weekly.

In preparing pit-coal for the blaſt-furnace, well underſtood among manufacturers by the term coaking, flat ſurfaces are appropriated. Theſe are firmly beat and puddled over with clay, ſo as to paſs the neceſſary cartage without furrowing or looſening the earth. Theſe ſpaces form ſquares, more or leſs oblong, and are called hearths; upon which the pieces of coal are regularly placed inclining to each other. Great care is taken to place each piece upon the ground layer on its acuteſt angle, in order that the leaſt ſurface poſſible may come in contact with the ground. By this means large interſtices are preſerved for the admiſſion and regular communication of the air neceſſary to excite and effect complete ignition.

The quantity of coaks charred in one heap or hearth, is various at different, and even at the ſame works. Forty tons of coals is amongſt the ſmalleſt fires, and ſome hearths again will admit of 80 or 100 tons. The length of the fire is in proportion to the quantity of coals built: the breadths and heights are alſo ſubject to no determinate ſtandard; but are from 30 to 50 inches high, and from 9 to 16 feet broad. In building each fire, they reſerve a number of vents

reaching

reaching from top to bottom, into which the burning fuel is introduced. This is immediately covered by ſmall pieces of coal beat hard into the aperture: theſe repreſs the kindling fire from aſcending, and oblige it to ſeek a paſſage by creeping along the bottom, which is moſt expoſed to air. In this progreſs the fire of each vent meets, and, when united, riſe gradually, and burſt forth on all ſides at once.

If the coal contains pyrites, the combuſtion is allowed to continue a conſiderable time after the diſappearance of ſmoke; the ſulphur then becomes diſengaged, and part of it is found in flowers upon the ſurface of the heap. If the coal is free from this hurtful mixture, the fire is covered up in a ſhort time after the ſmoke diſappears; beginning at the foundation, and proceeding gradually to the top.

The length of time neceſſary to produce good coaks depends upon the nature of the coal to be coaked, and the ſtate of the weather. In 50, 60 to 70 hours the fire is generally completely covered over with the aſhes of char formerly made: the coaks, thus entirely ſecluded from air, ſoon cool, and in 12 or 14 days may be drawn and wheeled to the furnace.

It is with pit-coal, in a great meaſure, as with wood, in the proceſs of charring. Coals do not always afford a weight of coaks in proportion to the quantity of carbon in the coal. It depends more upon the capability of the coal to reſiſt the waſte occaſioned by combuſtion, ſupported by external air, than upon the real quantity of carbon inherent in the coal; as may be ſeen by comparing the loſs of weight which coals undergo in the large way, and the reſults obtained from the ſame coals, by burning them unexpoſed to external air in the ſmall way.

The loſs ſuſtained in coaking coals fit for the purpoſe of manufacturing, or melting iron, is found to be nearly as follows:

2240 pounds of free coals - - yield 700 lbs. coaks, loſs 1540 lbs.
2240 - - of ſplint and free coal mixt - 840 lbs. coaks, loſs 1400 lbs.

2240 pounds of ſplint ſlightly mixt yield 1000 lbs. coaks, loſs 1240 lbs.
2240 - - of pure ſplint - - - 1100 - - loſs 1120 lbs.

This great weight thus loſt is chiefly carried off in ſmoke. If a veſſel is placed, filled with cold water, in the midſt of one of theſe maſſy columns of vapour, before the fire has penetrated to the ſurface of the heap, a conſiderable quantity of tar will condenſe upon its external ſurface: this will continue to increaſe till ſuch time as the water aſſumes the temperature of the ſmoke. At many iron works from 300 to 1000 tons of coals are thus weekly reduced to cinder. What a prodigious quantity of bituminous vapour, ſurcharged with tar, ammoniac and oil, muſt for the preſent be loſt!!

I have found the ſpecific gravities of the above coals and coaks to be as follow:

	Sp. Gr.	lbs. Avoirdup.	Sp. Gr.
Bituminous coal -	1·1801—Cubic foot	72·60—the coak	·3985
Free coal and little ſplints	1·1954—Ditto	73·75—Ditto	·4798
Mixture ſplint and free	1·2307—Ditto	76·91—Ditto	·6547
Pure ſplint - -	1·3121—Ditto	82·00—Ditto	·9533

Reſults obtained from the ſame coals by ignition unexpoſed to external air:

Bituminous coal 100 pts. comp. of Bit^{a}.	51·5	Carb. 3·65	Aſh. 12	S.g.·4534
Free coal, pure - - - -	44·8 -	53·45 -	1,75 -	·4827
Mixture of free and ſplint - - -	45·5 -	51 2 -	3,3 -	·6698
Pure ſplint - - - -	42·4 -	53·4 -	4,2 -	·9599

The comparative quantity of coaks produced from 100 parts in both ways will ſtand thus:

Bituminous coal coaked in air	31·20	Coaked, unexpoſed to air	49·5
Pure free coal and a little ſplint	37·50	Ditto - - -	55·2
Splint and free coal - -	44·59	Ditto - - -	54·5
Splint, pure - - -	49 10	Ditto - - -	57·6

Theſe experiments were performed on coals found immediately in this neighbourhood, part of which are uſed in the manufacturing of iron. The qualities of coal, however, even of the ſame ſeam, vary in different places.

Iron-

Iron-ſtone.

The ſubſtitution of pit-coal in the blaſt-furnace, in place of the charcoal of wood, firſt introduced to general uſe thoſe numerous ſtrata of argillaceous iron ores found ſtratified along with the other ſecondary formations of our globe. The intimate connection which nature had impoſed upon theſe two mineral ſubſtances, by the plentiful formation of them, almoſt always within convenient reach of each other, has been ſucceſsfully traced and beneficially developed in their mutual application to the manufacturing of caſt-iron.

Had nature not formed this immenſe ſtore of iron ſo congenial to the uſe of pit-coal combined in its preſent form, the application of caſt-iron to the various branches of machinery, and to the vaſt variety of uſeful and ornamental caſtings conſtructed for the conveniences and elegancies, had been greatly retarded, if not hitherto altogether kept back. At preſent it is by many believed—nor has any attempt in the large way ever contradicted it—that primary ores of iron, ſuch as the Cumberland and Lancaſhire ores, are incapable of affording caſt-iron ſufficiently carbonated, when ſmelted alone with pit-coal coaks, to be re-melted to advantage in the manufacturing of caſtings*. Certain it is that a larger por-

* I have not heard of any attempt to produce carbonated caſt-iron from theſe ores in the large way. The univerſal diffuſion of iron-ſtones renders this ſuperfluous; eſpecially as the uſe of Cumberland and Lancaſhire ore can only extend to the neighbourhood, or at moſt can only be uſed by ſtrangers whoſe works are within the reach of water-carriage. Their advantage therefore would only be local, and their utility reſtricted by the expence of carriage, of freight, or of both. As to the quality of iron they contain, I have not a ſcruple in aſſerting, that it can be called into exiſtence by means of the aſſay-furnace ſufficiently carbonated, even to exceſs, for any purpoſe. From theſe ores I have obtained reguli of ſupercarbonated crude iron covered with numerous ſpecks of plumbago. The ſame reſults being obtained from iron-ſtones in the ſame manner, though with a different application of ſolvents, am I not at liberty to deduce, that ſimilar effects could be produced in the large way, by varying the treatment and proportion of materials? Vide Aſſaying of Primary Ores by Fuſion.

tion of coaks is at all times neceſſary to correct the bad effects which theſe ores, eſpecially the former, would otherways produce in the blaſt-furnace, though uſed in very ſmall quantities.

Thoſe iron-ſtones with which Britain ſo much abounds, and which are now univerſally uſed for the production of caſt-iron with pit-coal, are commonly found in horizontal ſtrata, ſubject to the ſame acclivity and declivity with the other ſtratified ſubſtances under the ſurface; their inclination from the horizon varying according to the nature of the ground, and the diſpoſition of the imbedding and incumbent ſtrata. Such variety is exhibited, that ſtrata of iron-ſtone are found deſcending 1 yard in 24, 1 in 12, 1 in 8, and ſometimes 1 in 4. Let A B (Plate I. Fig. 7.) repreſent a line drawn parallel to the horizon, and C D a ſtratum of iron-ſtone. Suppoſe the horizontal line continued for 24 yards: at that diſtance the iron-ſtone will be found to have deſcended one yard of perpendicular meaſure, at the termination of the lines A B, A D; and if the ſame line is ſuppoſed to meaſure 4 or 8 yards, it will repreſent thoſe ſtrata that are arranged at a more diſadvantageous declivity. From this it is obvious, that where the acclivity or declivity of the metals is ſmall, the moſt extenſive and regular fields of iron-ſtone are to be found, and *vice verſa* where the metals lay more on edge.

Iron-ſtones are generally found imbedded in ſchiſtous clay more or leſs compact, but which moulders away when expoſed to air. They aſſume two different forms: regular connected ſtrata called bands, and ſtrata of detached ſtone found in diſtinct maſſes, from the ſize of the ſmalleſt bullet to the weight of ſeveral hundred pounds. Thoſe of the ſmall and middling ſizes, and which generally wear a flat ovular form, are called ball-ſtones: thoſe of greater weights are by the workmen denominated *lunkers*.

Both theſe ſpecies of iron-ſtone frequently accompany coal and limeſtone. In the former caſe they are commonly incumbent, and found almoſt in immediate contact with the coal:

coal: little extra labour is therefore requiſite to bring down the ſtone; and the double purpoſe of obtaining both materials is thus advantageouſly anſwered.

When ironſtone in bands accompanies limeſtone: it is moſt commonly of an inferior quality. Its component parts are chiefly calcareous, and the quantity of iron it contains is ſmall. Ball ironſtones found near to lime are of a much ſuperior quality, and for the moſt part contain a conſiderable proportion of iron.

Thus ſtratified in the vicinity of lime, many ironſtones are found with various impreſſions of marine remains; and not unfrequently compact and entire ſhells, univalve and bivalve, are found in the heart of the band. It is however ſtill more difficult to conceive how ſhells could be depoſited, diſtant from lime, imbedded in ironſtone, incumbent on coal, at the great depth of 80 yards from the ſurface. In our neighbourhood, at this depth, a ſmall band of ironſtone is found completely covered and interſperſed with diſtinct muſcles of an ordinary ſize.

Among the great variety of rich ironſtones found in Lancaſhire, the Rottenburn ſtone challenges particular attention, for the beautiful ſpecimens it affords of vegetable decompoſition and impreſſion. This ſtone conſiſts of a band and an accompanying ball. The former abounds with fine ſpecimens of the ramification of trees, ſhrubs, &c. In the proceſs of decay, and the ſubſtitution of mineral in place of vegetable ſubſtance, the more ligneous parts and the bark are diſtinctly preſerved from the heart of the ſhoot. The former are found of a proper thickneſs, conſiſting of pure calcareous earth, encircling the central parts, which commonly have been diſplaced and occupied by the ſame compound as the general maſs. As the external parts of the vegetable ſeem to have been laterally formed, it is preſumed that they have withſtood the decompoſition of the ſofter parts, and have only been diſplaced afterwards by a filter which has contained calcareous earth in ſolution. This iron-ſtone contains 37 lb.

in

in 100 extremely ſuſceptible of receiving the carbonaceous principle.

The ſtratum of detached ſtone is externally marked with vegetable impreſſions, from the ſize of trees to ſmall branches. The exterior appearance of this ſtone greatly reſembles wood dug from a moraſs or bog, with knobs or excreſcences of various ſizes. Theſe ſtumps are from 9 to 18 inches long, and are oval or round of various diameters: they ſplit lengthways like a piece of wood, and their internal ſurfaces exhibit the moſt perfect traces of their original formation. In moſt of them the fibres, as in wood, are ſeen running lengthways, and a croſs ſection preſents the commencement of ſhoots of various thickneſſes. In one of them I found a diſtinct nut, and a piece of the filament ſtill in a vegetable ſtate. The ſame piece of ſtone afforded a confuſed coagulation of mineral and vegetable ſubſtances. In the aſſay this ball-ſtone yielded me 40½ per cent. of iron.

Another variety of iron-ſtone, which we have in this country, and which will be deemed no leſs curious by the mineralogiſt, affords maltha, bitumen, mineral pitch, &c. This combuſtible is found in the heart of large flat rounded balls of iron-ſtone, occupying a number of interſtices, and reſembling a cement for the frittered pieces of ſtone. It is commonly found attached to pure calcareous ſpar, which has alſo found its way into theſe vacuities. I obſerved that where the ſpar was thickeſt, the bitumen was proportionally thin: in ſome places it totally diſappeared, and the chaſm became entirely filled with ſpar: this led me to conjecture, that the deſtruction of the bitumen was effected by the filter which had depoſited the lime it held in ſolution; and that even at the time the ſtone was dug, nature was employed in this progreſſive and tedious operation. I have found ſome pieces of plant along with the bitumen, which reſemble that from which ſoda is made; thoſe, though preſerved in ſhape, were equally inflammable with the pitch. The diſtillation of 437 grains afforded me a rough light charcoal, which weighed only

only 49 grains; this, when expoſed to fire in contact with air, burnt without a reſidue; hence I conclude it to be pure carbon. This iron-ſtone in the aſſay-furnace yields 36 pounds of iron in 100.

All theſe ſtrata of iron-ſtone bear the moſt evident marks of the agency of water. It is not ſo difficult to conceive how regular ſtrata of iron-ſtone ſhould be formed by the depoſition of water: but how ſuch huge maſſes, broken off, detached, rounded and impreſſed with various external ſhapes, abounding with the forms of ſubſtances formerly foreign, now tranſpoſed, and forming part of the ſame maſs; regularly depoſited in ſtrata, ſometimes incumbent, ſometimes decumbent to lime, coal, and their own ſpecies, is a work of real admiration; in attempting to ſolve which, conjecture muſt ſupply the place of certainty, and analogy muſt ſerve in place of ſtrict demonſtration.

The manner and diſpoſition of the Rottenburn ball iron-ſtone reſembles more an irregular diffuſion of wood, felled into lengths, and afterwards changed to ſtone; than a regular ſtratification, depoſited by the decompoſition of water, or the eſcape of an acid.

The phenomena attending water depoſiting matter in ſolution, and of transforming the nature of vegetables, wood, &c. I have frequently and ſatisfactorily obſerved. Within the laſt four months I have obtained ſtrata of an inch thick, whoſe ſurface, expoſed to the action of the water, diſplayed an entire covering of calcareous cryſtals of an ice colour, ſo ſmall as not to be diſtinguiſhed by the naked eye. The fracture of ſuch a thickneſs preſents from 12 to 15 various-coloured ſtrata ſucceſſively depoſited; chiefly lime, with a ſmall portion of fine ſilex and magneſian earth. By expoſing it a few days to dryneſs, it acquires conſiſtency and firmneſs almoſt equal to limeſtone. Heat is requiſite to diſengage this ſediment. Its affinity in this caſe is greateſt to wood, leſs to iron, and leaſt of all to lead. Pieces of wood boiled in this water become ſoftened: the liquid penetrates to the heart of the

the piece, opens the pores of the wood, and admits the particles of matter. By this accumulation of weight the wood ſinks, and in 15 to 18 days a ſoft ſlime is formed over all its ſurface; this gradually hardens into a cruſt, and diffuſes itſelf inwards: during the progreſs of formation the ſlimy matter which is next to the wood receives the impreſſion of the fibres, and communicates their form to the maſs. Hence impreſſions are conveyed to ſtones, which are afterwards formed when in a compact ſtate.

I am afraid it will be thought that I have exceeded the limits I propoſed to myſelf; but the few particulars I have related concerning the depoſition of matter from water may tend to explain ſome part of the phenomena attending the formation of ſome iron-ſtones. I ſhall probably on a future occaſion give ſome further obſervations concerning the effects of this water, and the progreſs it makes in ſubſtituting one ſpecies of matter in the room of another, and in the formation of ſtrata.

Working of Iron-ſtone.

When iron-ſtone is found near the ſurface, it is only neceſſary to unbare the ſoil and the ſuper-incumbent earths: the ſtone then preſents itſelf like a pavement more or leſs inclined, and is eaſily raiſed by the application of wedges, bars, &c. &c. But as all ſecondary ſtrata deſcend, according to the declivity impoſed upon them by nature in their formation, it is obvious that, in proportion as the excavation extends at right angles to the line of level, the ſtone becomes gradually buried under an accumulating depth of earth, till ſuch time as the expence of throwing this off exceeds either the value of the ſtone, or the expence at which it could be procured by a different mode of operation. It therefore becomes neceſſary to make perforations by means of horizontal galleries, extended under the ſoil, ſo as to fall in with the declivity of the ſtrata: theſe catch the inclining ſtone for a ſtretch of 100 to 240 yards, according to the exiſtent circumſtances of the mine.

Theſe

Theſe galleries are in Scotland called the barrow roads. Whenever the miner has arrived at the extremity of his working, he turns round, and commences an excavation on his right and left hand, proportioned to the riſe and dip of the ſtone, to the extent of ſeveral yards on each; the accompanying ſhiſt and rubbiſh are packed into the vacuity behind him: ſhould there remain any ſuperfluity unpacked, it is wheeled to the mouth of the gallery along with the iron-ſtone. In this manner the miner returns, and brings along with him the whole iron-ſtone contained in 100 to 240 yards in length, and in 20 to 30 yards in width. The height of the gallery is commonly ſo ſmall, that the miner is obliged to perform his work upon his ſide: the wheelers are likewiſe obliged to puſh the barrow on all fours. This ſpecies of working is called under cover; and the attainment of a band of good iron-ſtone, though only four inches thick, will ſufficiently defray the expence of the operation. It is here alſo obvious, that this operation can only be carried a certain length in the ſame gallery, till ſuch time as the expence of wheeling out the ſtone muſt exceed the value of that ſhare of labour generally appropriated to it. A more economical method is therefore indiſpenſibly requiſite. This is effected by ſinking a pit 160 to 200 yards farther on the ſame line of level. When the iron-ſtone is found, the miner ſets off another gallery, or barrow road, towards his former working, and continues till he meets the termination of his *old waſte*: as formerly, he now begins his retreat, and carries with him a ſimilar portion of iron-ſtone from each ſide of the gallery. The quantity of iron-ſtone by weight obtained from ſuch a *working*, depends entirely upon its extent and the thickneſs of the band. A ſquare yard of iron-ſtone containing 9 cubical feet, as it lays ſtratified, will weigh from 1850 to 1900 pounds weight. The other ſide of the pit is next perforated, and the ſame operation completed. When the iron-ſtone is thus exhauſted, another pit ſunk at a ſimilar diſtance from the termination of the ſecond

cond gallery in the firſt, opens up a new field of ſupply. In this manner iron-ſtone is continued to be raiſed, till ſuch time as the *field* is totally exhauſted.

Theſe extenſive excavations commonly collect a conſiderable quantity of water, which would ſoon impede the progreſs of the workmen: various means have been contrived to remove this conſequent obſtruction. Theſe have chiefly conſiſted in running a counter gallery as far to the declivity of the *metals* as poſſible, and of paſſing the water into it by means of filtration, or communications betwixt gallery and gallery. Where a ſufficient quantity of running water preſents itſelf, water-wheels have been applied, to extract the water from one general reſervoir by means of pumps.

Strata of iron-ſtone are from $\frac{1}{2}$ an inch to 12 inches in thickneſs. Thoſe of 3, 4, 5 and 6 inches are moſt commonly met with; they are alſo reckoned to contain a quantity and quality of iron ſuperior to larger bands. Ball and lunker iron-ſtone, however large, contain always a ſuperior quantity of iron, and are eaſier reduced in the blaſt-furnace.

IV. *On Preſerving Seeds of Plants in a State fit for Vegetation. By* JOHN SNEYD, *Eſq. of Belmont, Staffordſhire. From the* Tranſactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

MANY years ago having obſerved ſome ſeeds which had got accidentally amongſt raiſins, and that they were ſuch as are generally attended with difficulty to raiſe in England after coming in the *uſual way* from abroad, I ſowed them in pots, within a framing; and as all of them grew, I commiſſioned my ſons, who were then abroad, to pack up all ſorts of ſeeds they could procure in abſorbent paper, and ſend ſome of them ſurrounded by raiſins, and others by brown

brown moiſt ſugar; concluding that the former ſeeds had been preſerved by a *peculiarly favourable ſtate of moiſture* thus afforded to them. It occurred, likewiſe, that as many of our common ſeeds, ſuch as clover, charlock, &c. would lie dormant for ages within the earth, well preſerved for vegetation whenever they might happen to be thrown to the ſurface, and expoſed to the atmoſphere, ſo theſe foreign ſeeds might be equally preſerved, *for many months at leaſt*, by the kindly covering and genial moiſture that either raiſins or ſugar afforded them: and this conjecture was really fulfilled, as not one in twenty of them failed to vegetate; when thoſe of *the ſame kinds*, that I ordered to be ſent lapped in common parcels, and forwarded with them, would not grow at all. I obſerved, upon examining them all before they were committed to the earth, that there was a prevailing dryneſs in the latter, and that the former looked freſh and healthy, and were not in the leaſt infeſted by inſects, as was the caſe with the others. It has been tried repeatedly to convey ſeeds (of many plants difficult to raiſe) cloſed up in bottles, but without ſucceſs; ſome greater proportion of air, as well as a proper ſtate of moiſture, perhaps, being neceſſary. I ſhould alſo obſerve, for the ſatisfaction of the Society, that no difference was made in the package of the ſeeds, reſpecting their being kept in huſks, pods, &c. ſo as to give thoſe in *raiſins* or *ſugar any advantage over the others*, all being ſent equally guarded by their natural teguments. Whether any experiments of this nature have been made by others, I am totally ignorant; but I think that, ſhould this mode of conveyance be purſued ſtill more ſatisfactorily than I have done, very conſiderable advantages might reſult from it.

V. *A quick and eaſy Method of converting Weeds and other Vegetable Matter into Manure. By Mr.* BROWN *of Derby. From the* Tranſactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

I BEG leave to communicate to the Society, and, if thought worth notice, by them to the world, a compoſition for manure. Fearful it would not anſwer the purpoſe ſo fully as I could wiſh, I deferred it from year to year; but I now find, both by numerous trials made by my friends, as well as myſelf, the very great utility of the compoſition, as well as its cheapneſs, with the capability of its being made in any ſituation and in any quantity. The mode of making it is as ſimple as, I truſt, it will be found productive. It is nothing more than green vegetable matter, decompoſed by quick or freſh-burnt lime. A layer of the vegetable matter about a foot thick, then a very thin layer of lime, beat ſmall, and ſo on; firſt vegetable, then lime, alternately. After it has been put together a few hours, the decompoſition will begin to take place; and unleſs prevented, either by a few ſods, or a forkfull of the vegetables at hand, it will break out into a blaze, which muſt at all events be prevented. In about twenty-four hours the proceſs will be complete, when you will have a quantity of aſhes ready to lay on your land at any time you wiſh. Any and all ſorts of vegetables, if uſed green, will anſwer the purpoſe; ſay weeds of every deſcription. They will doubly ſerve the farmer, as they will not only be got at a ſmall expence, but will in time render his farm more valuable, by being deprived of all noiſome weeds.

But if this compoſition anſwers the purpoſe, as I flatter myſelf it will, a very ſhort time will ſee almoſt every weed deſtroyed, which ſuppoſing to be the caſe, I have made my calculations with clover, grown for the purpoſe; for inſtance, I will take one acre of clover, which at one cutting will produce

produce from fourteen to eighteen tons of green vegetable matter, and about three tons of lime: this, when decompoſed by the above proceſs, will yield aſhes ſufficient to manure four acres, the value of which I eſtimate at ſomething under four pounds; the clover, according to the value of land here, I will ſay two pounds, which, take the average of the kingdom, is too much. The lime I will alſo ſay two pounds; but that will vary, according to the diſtance it is to be fetched. Take them together, I think will be about the average value. Now if this is the caſe, and as far as I have been able to try it I find ſo, how valuable muſt it be to the community in general! If it anſwers the purpoſe, I ſhall feel myſelf much obliged by the Society making it as public as they poſſibly can.

The vegetables ſhould be uſed as ſoon after they are cut as poſſible, and lime as freſh from the kiln as the diſtance will allow of; as on thoſe two circumſtances depends the goodneſs of the compoſition.

VI. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth.* *By* M. DE SAUSSURE. *From* Journal des Mines. *No. XX.*

WHEN about to contemplate objects ſo complex as thoſe that muſt be ſtudied to found on obſervation the baſis of a theory of the earth, it is indiſpenſibly neceſſary that we ſhould previouſly form a regular plan; preſcribe for ourſelves a certain order; and minute down, if I may uſe the expreſſion, the queſtions which we wiſh to propoſe to nature. As the geologiſt commonly ſtudies and obſerves while travelling, the leaſt diſtraction may deprive him, perhaps for ever, of an intereſting object. Even without interruption the objects of his ſtudy are ſo various and ſo numerous, that ſome of them may eaſily eſcape his notice. An obſervation which

appears important by engaging his whole attention makes him often forget others: ſometimes he is diſcouraged by bad weather, or becomes abſent through fatigue; and the neglect produced by all theſe cauſes gives riſe to deep regret, and even frequently oblige him to turn back; whereas if he has a collection of memorandums on which he can from time to time caſt his eye, he will be reminded of all thoſe objects which ought to engage his attention. This collection, confined at firſt, will be extended and improved in proportion as he acquires ideas, and may furniſh hints to travellers who, without being verſed in geology, wiſh to collect, in the countries they viſit, obſervations that may be uſeful to thoſe who ſtudy that ſcience *.

Agreeably to theſe principles I have always prepared for all my journeys a liſt of thoſe objects, for examining which that journey was intended. I propoſe here, however, a more extenſive plan. I wiſh to direct the traveller, and even the ſedentary philoſopher, in all the reſearches which ought to engage their attention, if they are deſirous of contributing towards the progreſs of a theory of our globe. I do not flatter myſelf that I ſhall be able to give a complete view of every thing that remains to be done: what I offer will be only an imperfect ſketch, but this ſketch will be at leaſt uſeful till ſome one produce a better. Several of the obſervations and queſtions which I here propoſe as problematic, ſeem indeed to have been already reſolved; but as moſt ſolutions of this kind are founded merely on analogy, the contrary of which is always phyſically poſſible, it is proper, in my opinion, to keep the eyes of naturaliſts always open to the grand facts which may be intereſting to a theory ſo difficult and of ſo much importance.

* Voyage dans les Alpes, vol. i. Preliminary Diſcourſe.

CHAP. I.

Aſtronomical Principles.

1. A general ſyſtem of coſmology, in what regards the earth conſidered as a planet.

2. The figure and dimenſions of the earth determined.

3. The denſity of the earth determined by the deviation of a plummet near ſome mountains, the dimenſions and denſity of which are known.

4. Whether any principles or hypotheſes, depending on aſtronomical geography, can explain the great changes in the temperature of ſome parts of our globe?

5. The courſes of comets. Whether it be poſſible that they may have met with, or ſtill meet with, the earth in their orbits, and what are the effects of ſuch a meeting?

6. Whether it be poſſible, I do not ſay probable, that a comet, by paſſing through part of the ſun, may have detached from it the earth and the other planets?

7. Is it probable that the earth's rotary motion has been formerly more rapid than it is at preſent?

8. If the grand chains of mountains exiſted before the rotary motion of the earth, is it poſſible that that motion produced any change in their original ſituation *?

CHAP. II.

Chemical and Phyſical Principles.

1. The theory of attraction and chemical affinities; of ſolution, cryſtalliſation, and precipitation.

2. The theory of elaſtic fluids in general, and the cauſe of their elaſticity †.

3. The theory of caloric and light; of the origin and nature of the different gaſes, and of the atmoſphére. Electricity, and the aurora borealis.

* Tableau des Etats Unis. Note of M. A. Pictet, p. 125.

† Syſtem of M. Le Sage.

4. The theory of the calcination of metals, and of the decompoſition of water.

5. Meaſuring heights by the barometer.

6. How the temperature of climates is modified by the winds, evaporation, the nature and elevation of the ground.

7. Whether theſe cauſes are ſufficient to explain certain changes, ſuch as that of the plants and animals of warmer countries having been able to exiſt and multiply in the coldeſt countries?

8. Mineralogy, the nature of earths, ſtones, ſalts, bituminous ſubſtances and metals. The principles of their analyſis and nomenclature.

9. If it be poſſible to tranſmute one earth or one metal into another. For example, if it be poſſible that ſiliceous earth can be changed into calcareous earth in the bodies of marine animals; or, reciprocally, that calcareous can be changed into ſiliceous earth in mountains of chalk?

10. If it be probable, according to the conjecture of Lavoiſier, that earths are the oxyds of metals?

11. What idea can we form of one or more ſolvents which, either ſimultaneouſly or ſucceſſively, may have rendered ſoluble in water the different mineral ſubſtances which we ſee on the ſurface and in the bowels of the earth?

12. Can we believe that theſe ſolvents may have been afterwards deſtroyed; and that it is in conſequence of their deſtruction that the matters they held in ſolution were precipitated and became cryſtalliſed?

12. A. Or, can we believe, with Dolomieu, that all cryſtalliſations may take place without previous ſolution; and that it is ſufficient for this operation that the bodies be reduced to their elementary parts, and that theſe parts be ſuſpended in a fluid which gives them liberty to unite by their correſponding faces?

13. Can we ſuppoſe that the electric and magnetic fluids enter, as elements, into the compoſition of bodies?

14. Does

14. Does it appear probable that the nitric, muriatic, and boracic acids, as well as the three alkalies, are of new formation; while the ſulphuric, phoſphoric, carbonic, tungſtic, molibdic, and arſenic acids exiſted before the formation of animals * ?

15. If we believe that the mineral alkali or ſoda was of ancient formation, may we not ſuppoſe that the ancient ocean held this alkali in ſolution? That would explain how it might have diſſolved ſiliceous earth and argil without being able to nouriſh animals. Afterwards, when the marine acid was formed, or had iſſued from ſome cavity, the ſea might have become proper for animals, and improper for the ſolution of ſiliceous earth and argil.

16. Is it probable that in the firſt ages of the exiſtence of our globe its atmoſphere was higher than at preſent; that its lower ſtrata were thus of a much greater denſity, and ſuſceptible of receiving from the ſun a greater heat?

17. May we preſume that the waters of the ancient ocean, before the formation of the primitive mountains, had a heat ſuperior to that of boiling water?

18. What temperature may we ſuppoſe at preſent to exiſt at the centre of the earth?

19. Is it poſſible that the quartzy earth found in petrified vegetables and animals has proceeded from the ſubſtance of theſe bodies?

CHAP. III.

Hiſtorical Monuments.

Though the grand revolutions of our globe have been anterior to all hiſtories and monuments of art, light may, however, be acquired from the traditions which hiſtory has preſerved † :

* Theorie de la Terre de M. de Lametherie.

† And alſo from the analogy between the languages and cuſtoms of different countries. C.

1. In regard to the ſituation of thoſe countries which were firſt inhabited.

2. In regard to the order in which they were ſucceſſively inhabited.

We ſhall thence ſee whether it be true, as ſome traditions aſſert, that this habitation was determined by the progreſſive retiring of the waters; and by coming to periods leſs remote and leſs involved in obſcurity, hiſtory may point out to us—

3. The changes undergone by the ſeas, lakes, rivers, and even ſome of the ſolid parts of the globe.

4. It will throw ſome light on the origin of the different races of men and animals; on the modifications they have experienced; and on the real or pretended loſs of ſome of theſe races.

5. The deluges or great inundations; their epochs and extent.

6. Whether there exiſt proofs of the diminution of the water of the ſea; and what may be the cauſe of it?

7. If it be probable that large caverns have been opened in the bowels of the earth, and that theſe caverns ſwallowed up a part of the waters?

8. Do there exiſt any hiſtorical monuments which prove that the countries at preſent cold were formerly ſo warm as to favour the multiplication of plants and animals which are no longer found but in the torrid zone?

CHAP. IV.

Obſervations to be made on the Seas.

1. Their form, extent and ſituation; thoſe of their great gulphs and ſtraits; their relative elevation.

2. The ſenſible flux and reflux out of the ocean, at the extremity of ſome gulphs and in ſome ſtraits; their periods and their limits.

3. Their bottom; notes of the places where they are deepeſt, and of the moſt remarkable ſhoals; their poſition and extent.

4. Currents

4. Currents at the ſurface or at different depths; their direction, velocity and limits; their relation to rivers, the winds, and form of the coaſts; the matters which they accumulate, and the places where they depoſit them.

5. Subterranean mountains and valleys; their relation with iſlands, and even with the terreſtrial mountains and valleys.

6. The nature of the mud, ſand and rocks, of which the bed of every ſea is compoſed.

7. An analyſis of the water of the different ſeas; and, at leaſt, their ſaltneſs at different depths and in different climates.

8. Their temperature at different depths and in different climates.

9. The fiſh and teſtaceous animals peculiar to different ſeas, depths and climates, which may ſerve to characteriſe them.

10. In what the preſent ſeas differ, in a phyſical and chemical view, from the great ocean, which, according to ſome ſyſtems, is ſuppoſed to have covered the whole ſurface of our globe?

11. Can we believe that there are ſtill formed ſtoney ſtrata at the bottom of the ſeas, and that their waters have conſequently that diſſolving power which is ſuppoſed to have belonged to the ancient ocean?

CHAP. V.

Obſervations to be made on the Borders of the Sea.

1. If the ſea coaſt is ſteep; if it forms ſteep hills, to obſerve their height, their nature, and the ſtrata of which they conſiſt *.

2. To ſeek on theſe hills traces of the effects or abode of the waters at different heights above the preſent level, and at different depths below, ſuch as furrows, caverns, ſhells,

* 1. A. To note down every thing that relates to the deſtruction, more or leſs rapid, of theſe hills, and the banks and accumulations formed chiefly at the mouths of rivers. C.

pholades; to ſearch alſo for veſtiges of the labours of man, ſuch as excavations, rings for making faſt veſſels; in a word, to endeavour to aſcertain whether the ſea has the ſame level as it had in the remoteſt ages.

3. In caſe the level has changed, to examine whether that effect has been produced by a change in the ſea itſelf, or whether the ſhore rather has not been raiſed or depreſſed.

4. If the ſea coaſt is flat, to diſcover to what diſtance its acclivity is inſenſible; and to examine the nature of the ſand found on the ſhore.

5. Whether the grains of that ſand are round or angular, cryſtalliſed or not, quartzy or calcareous, or of any other kind of ſtone.

6. To endeavour to diſcover its origin, whether it can be conſidered as produced by detrition from the neighbouring mountains or hills; whether it may not have proceeded from ſome river which had its mouth in the neighbourhood, or whether it may not have been brought from the bottom of the ſea itſelf by the tide and the waves?

7. Whether this ſand contains, like that of Rimini, microſcopic ſhells of the order of thoſe called *pelagian?*

8. Whether there are not ſhells on the borders of the ſea; and, if there are, to determine thoſe by which that coaſt ſeems to be characteriſed.

9. Whether there are any rolled pebbles?

10. To examine, as in No. 2, chiefly on the ſhore, and even pretty far up the country, whether there are any proofs that the ſea gains on the land, or the latter on the ſea; and, in caſe the ſea ſeems to recede, to diſcover whether that may not be occaſioned by the land riſing by accumulations waſhed down from the higher grounds; by ſubterranean cauſes, or reciprocally.

11. If a progreſſive diſplacing of the ocean really exiſts, by what obſervations can the ſyſtems, which tend to explain it, be verified? Some have employed, for that purpoſe, the currents produced by the trade winds; others, the ſhock of

the

the tides and currents; and others, a change in the earth's centre of gravity, occaſioned either by depoſits tranſported by rivers to the ſea, or by the progreſſive movement of ſome maſs detached from the interior parts of the earth ſuppoſed to be concave *.

[To be continued.]

VII. *Analyſis of the Spinel Ruby. By* C. Vauquelin, *Inſpector of Mines and Member of the French National Inſtitute. From* Journal des Mines, *No. XXXVIII.*

Iron and manganeſe have long been conſidered as almoſt the only metals employed by nature to colour minerals; but though theſe metals may aſſume a multitude of different ſhades according to the proportions of oxygen which they contain, we however often ſee in nature bodies poſſeſſed of colours which neither iron nor manganeſe ever formed artificially or naturally when pure, and it is probable that we ſhall one day find many other colouring metals and alſo ſtones and earths.

I have already announced that the colour of the emerald, which all chemiſts aſcribed to iron, is owing to the oxyd of chrome. In examining the peculiar red colour of the ſpinel ruby with the reſults of the analyſis lately made of it by Profeſſor Klaproth, I began to doubt of that rich and beautiful colour being produced by the oxyd of iron, of which the Profeſſor found only 1·5 in 100 †. My doubts in this reſpect were ſtill increaſed by reading in Bergmann that the ruby fuſed with borax communicates to it a beautiful green

* 12. To obſerve whether there are not daily formed different kinds of ſtones in the places which are waſhed by the waters of the ſea. C.

† The number, nature and proportion of the principles found by Klaproth in the ſpinel ruby are ſtated as follows: Alumine 76; ſiliceous earth 16; magneſia 8; oxyd of iron 1·5:—Total 101·5.

colour,

colour, as well as by a paſſage of Klaproth, in which he ſays, that magneſia extracted from that precious ſtone, being diſſolved in the ſulphuric acid, had given to it a green colour. The rubies of different colours preſerved in collections, ſuch as the ſapphire-blue in the poſſeſſion of the Hon. Mr. Greville, the green belonging to Mr. Hawkins, and the white in the collection of Mr. Macie of London, authoriſed me to ſuſpect that iron is not the colouring principle of that ſtone.

Theſe different conſiderations induced me to make a new analyſis of the ſpinel ruby: and the reſult of this labour will prove, that my doubts were not without foundation, and that it not only does not contain a ſingle particle of the oxyd of iron, but that there is even no ſiliceous earth in it, as announced by Klaproth. The rubies employed for this analyſis were cryſtalliſed, tranſparent, and free from any foreign mixture.

Exp. I. A hundred parts of this ſtone being expoſed to a violent heat, loſt nothing of their weight, but their tint was weakened and changed to a roſe colour.

II. A hundred parts of the ſame ſtone reduced to a fine powder, and ſtrongly heated in a charcoal crucible, were agglutinated into one maſs of a greeniſh grey colour.

III. A hundred parts of the ſmall fragments of rubies reduced to an impalpable powder in a mortar of ſilex, were increaſed five parts.

IV. I heated for an hour, in a ſilver crucible, 100 parts of a ruby thus pulveriſed, with 300 parts of cauſtic potaſh: the mixture was not fuſed; on the contrary it was reduced to a pulverulent maſs of a green colour, of which ſome particles were merely agglutinated. I mixed this with diſtilled water, in which it was all ſo nearly diſſolved that there remained of it only ſome particles which weighed ſcarcely three parts. I poured upon the ſolution, which remained ſtill mixed with the undiſſolved matter above-mentioned, ſome diluted muriatic acid. The firſt portions of this acid made the ſolution aſſume the appearance of a maſs as thick as ſoup (bouillie), which was re-

diſſolved,

diſſolved, at leaſt for the greater part, by additional quantities of the acid. I warmed the ſolution by a gentle heat, and having filtered it, there remained on the paper three parts of a roſe-coloured powder, which was ruby, not decompoſed. This I placed apart, that I might operate only on that portion which had been attacked.

V. The muriatic ſolution above mentioned having been evaporated to dryneſs by a gentle heat, I poured upon the reſiduum a large quantity of diſtilled water: almoſt the whole of it was diſſolved. There remained only five parts of a grey powder, which melted with borax, to which it communicated a green colour.

VI. I ſubjected theſe five parts to different teſts, which ſhewed, that they were ſiliceous earth mixed with a little alumine, and coloured by a matter, of which I ſhall ſpeak hereafter *.

VII. I precipitated the muriatic ſolution of Exp. V. with carbonat of ammonia. When I judged that I had added a ſufficient quantity, I boiled the mixture for a quarter of an hour, in order to expel the carbonic acid, and favour the precipitation of the lime or magneſia, if there were any of theſe in it. By theſe means I obtained an abundant white precipitate, which I boiled with a ſolution of cauſtic potaſh. The greater part of this precipitate was diſſolved. There remained only $10\frac{1}{2}$ parts of a brown ſubſtance inclining to violet, but which turned to a yellowiſh-green colour, by drying in a gentle heat.

* In another analyſis of the ruby I had for reſiduum, after the evaporation of the muriatic ſolution, but five parts and a half of ſiliceous earth, ſlightly coloured green, and without any mixture of alumine. This difference ariſes from the degree of heat given to the matter towards the end of the evaporation, or from the ſaline maſs not being equally ſtirred throughout. In the latter caſe it happens that there are parts which dry too much, and others which do not dry ſufficiently. Hence it happens that moleculæ of alumine are abandoned by the acid, while moleculæ of ſilex remain combined; and this was the caſe in my firſt analyſis.

VIII. Theſe $10\frac{1}{2}$ parts were diſſolved by the ſulphuric acid. The ſolution had a greeniſh colour. This ſolution mixed with the ſaturated carbonat of potaſh, precipitated a greeniſh matter, which, when waſhed and dried, weighed two parts. A ſmall portion of this precipitate melted with borax communicated to it a beautiful emerald green colour *. This matter, which I placed apart, I ſhall ſpeak of hereafter.

IX. As I had diſſolved in the ſulphuric acid 10·5 of matter, and as the carbonat of potaſh precipitated only 2, there muſt have remained 8·5 in the ſolution. Suſpecting therefore that the matter was retained there by an exceſs of the carbonic acid, I boiled the liquor for ſome minutes, and I obtained a white granulated precipitate, weighing 16 parts, which by calcination were reduced to 8. This matter, combined with the ſulphuric acid, gave a ſalt cryſtalliſed in tetraedral priſms, terminated by pyramids with four faces, the taſte of which was firſt ſweet, and afterwards bitter; which was not precipitated by the ſaturated carbonat of potaſh; was only partly ſo by ammonia; and, in a word, which preſented all the characters of ſulphat of magneſia. The ruby therefore, according to this experiment, ſhould contain 8 parts of magneſia in 100; but as $\frac{1}{2}$ part was wanting in that ſubjected to experiment, we may eſtimate the quantity at 8·5.

* In heating the colouring matter of the ruby with borax over charcoal, and ſtopping the operation before the effervеſcence had ceaſed, I have twice obtained a vitreous globule of a red colour, perfectly ſimilar to that of the ruby; but in heating again this red globule, the effervеſcence was renewed, and the globule became of an emerald green colour. In vain did I afterwards try to make the red colour re-appear, whether I applied the exterior or the interior flame of the blow-pipe. It is even very difficult to obtain, in the firſt inſtance, the vitreous globule of a red colour. It is neceſſary for that purpoſe that the colouring matter ſhould not touch the charcoal; that it ſhould not be added till the borax is melted; and that it ſhould be heated with the exterior flame. Though I often attempted to produce this phenomenon, I never ſucceeded but twice.

X. I united the five parts of Ex. VI. and the two parts of Ex. IX; boiled them five or ſix times ſucceſſively in a porcelain veſſel with concentrated nitric acid, evaporating each time to dryneſs. The matter at firſt aſſumed a beautiful dark green colour, and at the end of each operation it boiled and was puffed up like alum. At laſt, when the greater part of the acid was evaporated, and the matter began to dry, it aſſumed an orange yellow colour. After treating the matter in this manner, I mixed with it a little pure cauſtic potaſh; and when the mixture was well formed and reduced to a kind of paſte, I diluted it with diſtilled water, in which almoſt the whole of the matter was diſſolved. Nothing remained but a little grey matter which weighed about $1\frac{1}{2}$ parts, and which I found to be ſiliceous earth. The alkaline ſolution had a weak golden yellow colour; and as it contained an exceſs of alkali, I added, in order that it might be ſaturated, a few drops of nitric acid. By this addition there was produced a ſlight white precipitate, which weighed at moſt one part, and which appeared to me to be alumine. The liquor had then a reddiſh colour.

XI. As I ſuſpected, from all the phenomena which had appeared during the courſe of this analyſis, that the colouring matter of the ruby was chrome, I mixed the liquor of the preceding experiment, firſt, with nitrat of lead, and I immediately obtained a precipitate of a beautiful orange-yellow colour; ſecond, with nitrat of mercury, and there was produced a depoſit of a cinnabar red colour; and, third, with the nitrat of ſilver, which gave a precipitate of a crimſon red colour. I was convinced by theſe phenomena that the ruby, like the emerald of Peru, contains a certain quantity of chrome, to which it is indebted for its colour. But it ſeems difficult at firſt to reconcile the colour of the emerald with that of the ruby, by referring them to the ſame ſubſtance; for nothing ſeems more remote from green than red. If we however recollect that this metal is ſuſceptible

of

of aſſuming different colours according to the quantities of oxygen which it abſorbs; that when it is ſaturated with this principle, it is red and acid; and when it contains leſs, it is green, and in the ſtate of an oxyd, we ſhall readily conceive how this oxydated metal may colour the emerald and the ruby. It follows then from theſe conſiderations, that chrome exiſts in the emerald in the ſtate of an oxyd, and in the ruby in the ſtate of an acid; and that this acid is there, doubtleſs, in a ſaline combination with alumine or magneſia, and perhaps with both at the ſame time. With regard to the proportion of the chromic acid in the ruby, I have not been able to determine it very accurately, on account of the affinity which it has with alumine, from which it is difficult to ſeparate it completely. I am however of opinion that it may be eſtimated, without committing any very ſenſible error, at between 5 and 6 parts in 100 of ruby.

XII. I now return to the ſolution of alumine in cauſtic potaſh (Exp. VII.). I ſuper-ſaturated it with the muriatic acid, and precipitated it afterwards by the carbonat of ammonia. The depoſit waſhed and kept at a red heat for a conſiderable time weighed 85 parts. This matter had all the properties of alumine. As I had however ſcarcely found any ſiliceous earth during the courſe of this analyſis, and as Klaproth ſays that he obtained 16 in 100 parts of this ſtone, I wiſhed to aſſure myſelf whether there might not be ſome of it remaining in the alumine. For that purpoſe I diſſolved the 82 parts above-mentioned in the ſulphuric acid, and I indeed obtained an inſoluble reſiduum which weighed three parts, and which was ſiliceous earth. This, with the $1\frac{1}{2}$ part obtained (Exp. X.), makes $4\frac{1}{2}$ parts. But it muſt be recollected, that during the pulveriſation of the 100 parts of ruby, the details of the analyſis of which I have explained, 5 parts were taken from the mortar of ſilex; from which it follows, that the $4\frac{1}{2}$ parts of this ſubſtance found in the courſe of theſe operations did not belong to the ruby. Whatever method

method I employed, and whatever care I took, I could never obtain a larger quantity, and therefore it is very probable that Klaproth was deceived in this reſpect.

Now, to eſtabliſh the proportions of the principles of the ruby, I muſt here obſerve, that of 100 parts ſubjected to analyſis, 97 only were attacked; but 97 having furniſhed 85 of alumine (Exp. XII.), 3 of which were to be taken away for the ſiliceous earth, 100 would have given 82·47; 8·5 of magneſia having been obtained from theſe 97, 8·78 would have been found in 100. In the like manner, inſtead of 6 of the chromic acid, we ſhould have had 6·18. Thus, 100 parts of ſpinel ruby conſiſt of alumine 82·47, magneſia 8·78, chromic acid 6·18. Loſs 2·57. Total 100.

XIII. To prove the correctneſs of the reſults of the preceding analyſis, I repeated it by following another method. I heated 100 parts of ruby, reduced to a fine powder, for ſeveral hours with concentrated ſulphuric acid. I obtained a ſolution, almoſt complete, by the addition of a ſufficient quantity of water. There remained nothing but 5 or 6 parts of a grey powder, which had all the characters of ſiliceous earth, and which was only mixed with a little chrome.

The ſolution evaporated to the conſiſtence of ſyrup gave radiated cryſtals without ſolidity; but theſe cryſtals, re-diſſolved in water, and the ſolution mixed with a ſufficient quantity of the ſulphat of potaſh, gave octaedral cryſtals of alum. The whole 100 parts of the ruby thus diſſolved in the ſulphuric acid furniſhed me, in ſeveral ſucceſſive cryſtalliſations, with about 800 parts * of alum, without reckoning the latter portions which I could not entirely ſeparate from the mother water. This mother water had a green colour, and a bitter ſlightly metallic taſte. I diluted it with water, and mixed with it a ſolution of the carbonat of potaſh. There was formed a greeniſh white precipitate, which was a mixture of alumine and the oxyd of chrome. The liquor filtered

* The ſame article in the Annales de Chemie, Meſſidor An. VI ſtates this product at 775. EDIT.

and

and expoſed to heat depoſited a white powder, which, waſhed and dried, weighed 17 parts, that were reduced to 8·3 by calcination. They conſiſted of magneſia, ſtill mixed with a few particles of oxyd. The precipitate formed in the mother water by the carbonat of potaſh was treated with a ſolution of cauſtic potaſh. By theſe means the alumine was diſſolved, and the oxyd of chrome remained without undergoing any ſenſible alteration: it weighed 5 parts.

This analyſis perfectly confirms the former; for, ſome ſlight differences in the proportions excepted, it abſolutely gave the ſame reſults. It proves above all that the ruby does not contain ſiliceous earth, and that the ſmall quantity found in the products was furniſhed by the mortar in which the ſtone was pounded.

I muſt here obſerve, that it does not always happen that the whole maſs of the ruby is diſſolved during the firſt operation. There remains ſometimes ſeveral parts which have undergone no alteration. This depends on the time employed for ebullition, and ſtill more on the degree of fineneſs to which the ſtone is reduced before it is ſubjected to trial. But when that happens, after having waſhed the reſiduum, which is inſoluble in the acid, it muſt be dried, pounded again, and treated in the ſame manner as before. Nothing then ought abſolutely to remain but the ſiliceous earth belonging to the mortar.

XIV. The muriatic acid diſſolves the ruby alſo: but a conſiderable portion of it is required; becauſe it volatiliſes in a moderate heat, and without a ſtrong degree of heat it makes no ſenſible impreſſion on that ſubſtance. I obſerved that this acid diſſolves the principles of the ruby in the ſame proportions as they hold between themſelves in the ſtone; for the portion not attacked abſolutely preſerves the ſame ſhade of colour as that which it had before ſubjected to the action of the acid. This proves that it does not diſſolve one principle in preference to another, and that they are in a ſtate of real combination in the ruby.

From theſe conſiderations it would appear natural to conſider the ruby as a ſaline ſubſtance, compoſed of two baſes, alumine and magneſia, and of an acid called the chromic acid.

When I announced to the National Inſtitute that I had not found magneſia in the ruby, I was however far from imagining that Klaproth was deceived; ſo much confidence did I place in the labours of that able chemiſt. I choſe rather to conclude at that time, that the ruby I had examined was different from his. But I was in an error in that reſpect, as I was convinced by a new analyſis, which I made of about 16 grammes of the ſame ruby; and it was from this latter labour, carried on in a manner ſomewhat different, that I eſtabliſhed the proportions of the principles of this ſtone, as already enumerated. This proves the neceſſity of employing rather large maſſes, in order to find ſmall quantities of matter. I thought it my duty to make this public acknowledgement, both that I might render juſtice to accuracy and to the ſagacity of a man who has given ſo many proofs of it, and to avoid the reproach which might have been thrown out againſt me, of wiſhing to conceal an error into which I had fallen.

VIII. *Deſcription of a remarkable Spring of Freſh Water, which riſes through the Water of the Sea. By the Abbé* SPALLANZANI. *From the* Journal de Phyſique, *Vol. XXIX.*

THIS ſpring riſes through the ſalt water at the diſtance of ſixty-five feet from the ſhore and about a mile from Spezzia. It raiſes itſelf ſome inches above the ſurface of the ſea, and forms a ſort of accumulation, ſhaped like a button of about twenty feet in diameter. This button, when the ſea is perfectly calm, is full of watery radii, exceedingly perceptible. The water of which they are formed ſeems a little turbid; and this is very apparent, eſpecially when it has

rained: the ſurrounding water is on the other hand perfectly tranſparent. Theſe radii will not ſuffer a boat to remain ſteady on the centre of the button, but, as may be readily ſuppoſed, throw it back to the circumference. M. Spallanzani, however, found means to fix himſelf in that poſition, and was thence enabled to examine carefully the water at the bottom, as well as that at the ſurface.

The water at the ſurface is not freſh, but a little leſs ſalt than that by which it is ſurrounded. The depth of the ſpring is $38\frac{1}{2}$ feet. When the heaving-lead approaches the bottom, it is obſerved that the ſmall line to which it is made faſt begins to tremble; and as this trembling is obſerved no where elſe, it is plain that it is occaſioned by the violent impulſe of the water of the ſpring againſt the bottom of the lead. The water being leſs ſalt at the ſurface than the ſea-water, with which it has mixed itſelf, it is natural to ſuppoſe that it is perfectly freſh at the bottom. To aſcertain this, M. Spallanzani invented a machine, by which he could draw up ſome of it from the bottom, in ſuch a manner as not to be mixed with the ſalt water by the way; and the water procured in this manner, though exceedingly turbid and ſlimy, was found to be perfectly freſh. He remarked alſo, that this water, when compared with the ſea-water, was remarkably cool, which aroſe probably from its riſing from ſome depth under the earth. The braſs machine alſo was once very much beat together, which could be occaſioned by nothing elſe than the violence with which the water iſſued from the ground, and by which the machine had probably been daſhed againſt a ſtone.

M. Spallanzani is of opinion that the origin of this ſpring is as follows:—There are two ſmall ſtreams which flow from the ſide of a hill at the diſtance of three miles from Spezzia. Theſe ſtreams are afterwards united, and throw themſelves into an unfathomable abyſs, from which the water, as it is ſufficiently ſecured from the ſummer heat, forces its way through the earth, and ſupplies ſufficient nouriſhment to the fountain that ſprings up through the ſalt water.

IX. *Experiments reſpecting the Effects of Electricity on the Fermentation of Vegetable and the Corruption of Dead Animal Subſtances.* *By* M. Achard. *From* Memoires de l'Academie de Berlin.

IT is a well-known obſervation, that, after a ſtorm, fleſh, either raw or boiled, acquires a putrid ſmell, which in the latter is particularly acid. It is known alſo, that grain ſuffered to ferment for the purpoſes of brewing or diſtilling, undergoes, during ſtormy weather, very ſudden and perceptible changes. On ſuch occaſions it is often extremely difficult to obſerve where the firſt degree of fermentation ceaſes, as it paſſes ſo ſpeedily, and the ſecond degree or the acetous fermentation takes place before one is aware. To aſcertain, therefore, whether the electric matter, which during ſtormy weather is ſo abundant in the atmoſphere, has any ſhare in theſe phenomena, M. Achard made the following experiments.

He cut a piece of raw beef into three parts, and electrified the firſt poſitively for ten hours without any ſhock; the ſecond he electrified for as long negatively, and the third he did not electrify. Theſe three pieces were left in the ſame apartment, and expoſed to the ſame degree of heat. When examined next day, both the pieces which had been electrified appeared to be tender, but were free from the leaſt bad ſmell. On the fourth day the electrified fleſh had an intolerably fetid ſmell, and that which had not been electrified began to ſmell a little.

M. Achard repeated theſe experiments with boiled veal. That which was electrified had the next day an acid ſmell and an unpleaſant taſte; but that which had not been electrified continued ſweet for three days, and only on the fourth day began to have an acid ſmell.

M. Achard then killed ſeveral birds by electric ſhocks, and at the ſame time deprived others of life by ſticking a

needle through their heads, and, placing them all in the ſame temperature, covered them with glaſs receivers in order to preſerve them from inſects. Having obſerved the gradual progreſs of corruption in both, he plainly perceived that it took place much ſooner, and advanced more rapidly in thoſe killed by electric ſhocks than in thoſe deprived of life by the needle. In thoſe alſo to which a ſtronger ſhock had been given, the degree of corruption was far ſtronger than in the others; and the cauſe in all probability was, that in this caſe the veſſels containing the animal fluids were ſuddenly deſtroyed, by which means theſe fluids had diffuſed themſelves through the particles of the body, and might thus accelerate putridity.

It clearly follows from theſe experiments, that electricity accelerates corruption, and that the putrefaction of fleſh after a ſtorm muſt be aſcribed ſolely to the more abundant accumulation of the electric matter at that time. M. Achard ſaw that this was the caſe in regard to ſeveral perſons killed by lightning. The body of a farmer, who loſt his life in this manner on the 2d of July, between five and ſix o'clock in the evening, emitted next morning a very perceptible fetid ſmell, which in the evening was totally inſupportable.

M. Achard took a handful of rye, which had been brought to a ſtate of fermentation in order to be diſtilled, and divided it into two portions, one of which he electrified. Five hours after being electrified, the vinous fermentation was over in the firſt portion; but this was not the caſe in regard to that which had not been electrified, till after eight hours. M. Achard repeated this experiment in ſuch a manner that he ſent a number of ſtrong ſparks through a portion of rye, inſtead of giving it an electric bath, and always found, except in one caſe, that fermentation was accelerated by the electricity. The caſe in which a contrary effect was produced, may have been occaſioned by ſome circumſtance which eſcaped M. Achard's attention.

On

On this occaſion M. Achard made two experiments alſo, in order to aſcertain what effect would be produced on air when electrified without ſparks. The object of his firſt experiment was in particular to diſcover whether the atmoſphere, by being electrified, would become oxygenated, or retain its goodneſs; and that of the ſecond, to determine whether a certain volume of air would be enlarged when electrified poſitively, or be diminiſhed when electrified negatively.

For this purpoſe he took a Leyden flaſk filled with air, the degree of the oxygenation of which he had previouſly aſcertained by an eudiometer, and electrified it as ſtrongly as poſſible: he then let it ſtand a few hours, and examined the air again; he, however, found neither abſorption nor dilatation to have taken place: and the caſe was the ſame when he expoſed the jar to abundance of ſparks; from which it appears, that the quality of the air is not changed by electricity.

He then electrified a jar cloſely ſtopped, through the cover of which a bent glaſs tube proceeded downwards parallel to the ſide of the jar, and the exterior part of the tube was placed in a ſmall veſſel filled with water. He charged this jar poſitively and negatively. Had the poſitive electricity occupied that ſpace which the air before occupied, the water muſt have ſunk in the tube; and had this ſpace been leſſened by the negative electricity, the water muſt have riſen in the tube. As neither of theſe was the caſe, the electric matter muſt paſs through the interſtices of the air without cauſing a farther ſeparation of its component parts; and that matter alſo which goes out in electrifying negatively, muſt be contained merely in the interſtices, without occaſioning any alteration in the particles of the air.

X. *Obſervations and Experiments on Staining Wood. By Profeſſor* BECKMANN. *From* New Tranſactions of the Royal Society of Göttingen, *Vol. VI.*

THE oldeſt inlaid works now extant are preſerved in Italy, and the moſt highly eſteemed of theſe are thoſe made by John of Verona, a monk and cotemporary of Raphael, who was born in 1470, and died in 1537. He was invited to Rome by Pope Julius II. in order that he might add to the ſplendour and magnificence of the Vatican; and he left behind him many ſpecimens of his art at Sienna, Naples, and other Italian cities. The works of this artiſt, on account of the variety and beauty of the ſtained pieces of wood employed in them, are ſtill celebrated among connoiſſeurs, and preferred to all new works of the like kind. It is, however, to be lamented, that the proceſſes uſed by John of Verona are at preſent altogether unknown, though the wood he employed was chiefly of European growth. Veneered or inlaid works are now ſo much in vogue, that there are few houſes in which ſome of the furniture is not ornamented in this manner; and the ſums of money expended every year for different kinds of foreign wood, neceſſary to ſupply this luxury, is very conſiderable. Theſe woods are imported chiefly from India by the Engliſh, Dutch and French; and ſome of them are of more value than the beſt copper, the filings of which might be employed to make imitations of them. That narrow diſtrict alone on the Rhine between Darmſtadt and Heidelberg receives annually for wallnut-tree wood the ſum of 10,000 florins. Since mahogany furniture however began to be uſed, our cabinet-makers have made ſcarcely any thing elſe than common works, becauſe we are accuſtomed to purchaſe from the Engliſh, not only the materials, but alſo the works themſelves; ſo that the time may come when no workmen of this kind will be found in Germany: on that account, it is well worth the trouble to make

expe-

experiments on the ſtaining of our own wood, in order to render them equal, if not to all foreign woods, at leaſt to ſome of them, ſince many things can be coloured in that manner which are harder and more compact than wood. The labours of Du Fay in this reſpect are well known; and it appears by ſome papers of his among the Memoirs of the Academy of Sciences, that rock cryſtal, when expoſed to the vapour of arſenic and antimony, aſſumes a red colour. Count de Borch's deſcription of the method of ſtaining marble in Italy may alſo be mentioned; and the proceſs by means of the ſmoke of oak chips, which is employed by the Dutch for colouring their tiles and earthen-ware. Canes are prepared for uſe in India, by dipping them in quicklime. That hard compact wood brought from America, and particularly Guiana, which, on account of its variegated and ſpotted appearance, is called *Bois de Lettres*, and which Aublet, who gives it the name of *Piratinera Guianenſis*, much admired, has its whole ſurface ſtained by the Indians with the blackeſt and moſt durable colours.—As the art of ſtaining wood ſeems at preſent to be nearly loſt, the following experiments may be of ſome utility to artiſts:

1. *By Means of Oils and Acids.*

Exp. I. A ſquare piece of plane-tree wood, a line in thickneſs, was put into pounded dragon's blood from the Canaries * mixed with oil of turpentine, and placed over the fire in a glaſs veſſel. The wood ſlowly aſſumed the colour, even before the ſpirit was volatiliſed. After more than an hour the veſſel was taken from the fire and ſuffered to ſtand the whole night, when the wood appeared of a mahogany colour, not merely on the ſurface, but alſo in the interior parts. The denſer fibres were ſomewhat leſs coloured, but this, inſtead of injuring the beauty of the wood, rather added to it. The red dye can be made ſtronger or weaker by taking a greater or leſs quantity of dragon's blood, and by a greater

* That from Madagaſcar is of an inferior quality.

or leſs degree of digeſtion and boiling. The wood of the plane-tree was choſen for this purpoſe, becauſe it can be eaſily ſawn and poliſhed; becauſe it has a white colour; is neither too hard nor too ſoft; becauſe it neither contracts nor warps; has beautiful white ſpots with veins that croſs each other; and becauſe artiſts who make inlaid work have long attempted to colour it by ſtaining. The wood, when ſtained, can very eaſily be freed from the dragon's blood adhering to it, by means of rectified ſpirit of wine. The ſpirit of turpentine makes the wood more compact, and renders it more ſuſceptible of a fine poliſh.

II. Gamboge, diſſolved in ſpirit of turpentine, gave to the whole ſurface of a ſmall piece of wood a moſt beautiful ſhining golden yellow colour. The fibres and veins, on the other hand, had aſſumed a colour inclining a little to red. A piece of the wood of the pear-tree aſſumed a darker colour, ſomewhat approaching to green, and which in part was nearly an olive colour. Different colours may therefore be obtained by employing different kinds of wood.

III. One part of dragon's blood, two parts of gamboge, with ſpirit of turpentine, gave to the wood of the plane-tree or beech, according to the mixture of the colours and the nature of the wood, a remarkable variation of dyes. A bit of beech wood ſeemed always to aſſume a blackiſh yellow colour; and was thoroughly ſtained, when moderate heat was kept up for a ſufficient length of time.

IV. Diſtilled verdigris (cryſtalliſed acetite of copper) could not eaſily be uſed in the above manner, as its colour is too much changed by oil and fire, as is known to thoſe who employ it as a pigment. The olive colour alſo does not penetrate to the interior part of the wood.

2. *By Means of Spirit of Wine.*

Exp. I. When dragon's blood and gamboge were merely diſſolved in ſpirit of wine, the extract was not ſufficiently ſtrong, and the dye was of no uſe. The proceſs, however, ſucceeds

ſucceeds when the ſpirit of wine has been long boiled over a ſlow fire till it is almoſt evaporated. The piece of wood appears then of a dark red colour, which is improved if the wood be waſhed in pure ſpirit of wine. But the colour is never ſo bright as that produced by means of an oil.

II. Gamboge with ſpirit of wine gave to wood in this manner a yellow, and gamboge and dragon's blood a yellowiſh red, colour.

3. *Experiment with Wax.*

White wood boiled in ſpirit of wine, to which, when it began to boil, wax was added, could not be made to aſſume the green or the red dye, even in its ſmall croſs veins, which were exceedingly porous.

4. *Experiments with diſſolved Salts and Metals.*

The following experiments with theſe ſubſtances, which have already been deſcribed by Macquer, ſeemed to be moſt ſucceſsful.

Exp. I. A ſolution of common alum (ſulphat of alumine) penetrates exceedingly well into wood which has been digeſted in it; ſo that hopes may be entertained of ſome thing being effected by it, as the white colour of every kind of wood becomes whiter by ſolutions of ſaline ſubſtances: this may be of great uſe to artiſts.

II. Wood ſoaked in a ſolution of gold aſſumed a red colour, but the inner part was only of a yellowiſh red.

III. Diſtilled verdigris diſſolved in vinegar ſtained wood green, but the colour could never be brought to a graſs green.

IV. Wood which has lain a long time under water becomes black, as experience ſhews, and looks as if charred. It, however, loſes none of its toughneſs or compactneſs; and many trees dug up in Holland from the turf earth are employed there for ſhip-building. This effect of the ſulphuric acid on wood gave occaſion to the following experiment.

Pieces

Pieces of different kinds of wood, of conſiderable thickneſs, were placed in the ſulphurous acid. In half an hour the whole ſurface of them was covered with a yellowiſh ſcurf, and the wood itſelf had the appearance of being charred. When waſhed in water, and expoſed ſome hours to the open air, it was obſerved that the black colour had penetrated ſtill farther, that the interior part only retained the natural colour, and that the wood was exceedingly cloſe and compact. After this wood had been ſeveral times rubbed over with the oil or ſpirit of turpentine, it became harder and firmer, ſo that it could receive the higheſt poliſh; by which means the colour was rendered more agreeable. This proceſs may be readily employed by artiſts, as it is eaſy, and does not require much expence.

V. Another black dye for ſtaining wood, which ſucceeds extremely well, and may lead to other uſeful experiments, is that formed with liver of ſulphur (ſulphuret of potaſh) and metallic ſolutions. As the ſulphurized hydrogen gas is ſo ſubtle that it penetrates the cloſeſt bodies, it might readily be conjectured that it would eaſily give a black colour to wood, if the latter could any how be made to imbibe it with a metallic ſolution. Pieces of different kinds of wood were placed, for ſeveral days ſucceſſively, in a ſolution of acetite of lead, and a ſolution of ſilver, copper, iron, and other metals; after which a ſolution of arſenical liver of ſulphur was prepared in the following manner: One part of the arſenical liver of ſulphur was mixed with two parts of clear quick-lime, in a porcelain veſſel, over which was poured ſix or eight parts of boiling water. The ſolution was then poured off, and the wood which had been impregnated with the above metallic ſolutions being placed in it and ſuffered to remain ſeveral days, the veſſel being cloſely ſhut, it aſſumed a black colour. The ſolution of acetite of lead produced the greateſt effect; that of ſilver next, and thoſe of the other metals leaſt of all. Spotted wood, and particularly that of the plane, beech and pear-tree, aſſumed the beſt colour.

It

It is therefore beyond all doubt that porous wood, ſuch as that of the lime, the elder, &c. could be ſtained much eaſier. Though the arſenical liver of ſulphur from lime may appear ſuperfluous, as the common, which is prepared from alkaline ſalts and ſulphur, can produce the ſame effect, the above proceſs however is that which ought to be recommended. This method of ſtaining may be conſidered as the beſt, becauſe it impregnates the wood with metallic particles, gives it a hardneſs ſuſceptible of a fine poliſh, and ſecures it from worms. The veſſel employed for this purpoſe muſt be either of porcelain, ſtone ware, or glaſs.

XI. *Deſcription of a new Diving Machine, proper for being employed in Rivers, &c. By* C. H. KLINGERT. *Extracted from the* Author's Account of it, publiſhed at Breſlau.

FOR ſeveral centuries mankind have employed their ingenuity to deviſe means by which they might deſcend into the water, without danger, in order to ſearch for ſunk bodies; but all the inventions hitherto made for this purpoſe have never fully anſwered the propoſed end, as they have all been attended with inconveniences. Of theſe inventions the beſt known is the diving-bell; but if a man deſcends in ſuch a machine to a certain depth under water, the air being condenſed in the bell in proportion as the height of the column of water of equal diameter becomes greater, he can breathe only for a ſhort time; and the very nature of the machine prevents him from moving about at pleaſure, which is an object of the utmoſt importance. A deſire to obviate theſe difficulties induced the author to contrive a machine in which a man could not only riſe and deſcend at pleaſure, but even at the depth of from 20 to 60 feet and more under water, walk, breathe, and move freely; and he was ſo far ſucceſsful that an experiment made with his

his machine in the river Oder, in the preſence of a great many ſpectators, exceeded what could have been expected.

It is well known, that the preſſure of water increaſes with its depth; and as water is a denſe body, a man cannot deſcend far in it without experiencing a very ſtrong preſſure: ſo that if a diver, whoſe head is five feet below the ſurface, attempts to breathe through a pipe, he finds himſelf incapable of inhaling the air, on account of the preſſure he ſuſtains on his breaſt. A man, therefore, to deſcend to a great depth, muſt have his body and breaſt free from the external preſſure of the fluid. In order to ſecure him from this inconvenience, the author has invented a ſort of harneſs, made of ſtrong tin plate, in the form of a cylinder, which goes over the diver's head, and which conſiſts of two parts, that he may conveniently thruſt his arms through it and put it on; alſo a jacket with ſhort ſleeves, and drawers of ſtrong leather. All theſe being water-tight, and cloſely joined round the body of the diver, ſecure every part of him but the arms and legs from the preſſure of the water, which at the depth of 20 feet will occaſion no inconvenience to theſe parts.

Fig. 1 (*Plate* 1) repreſents the diver covered with the harneſs, jacket and drawers.

Fig. 2 is the upper part of the cylinder, the diameter of which is equal to the breadth of a man at the top of the hip-bone. It is 15 inches in height, has a globular top, and is made of the ſtrongeſt tin-plate.

In the inſide of the cylinder, at *a*, is a ſtrong broad iron hoop, to enable it to withſtand better the preſſure of the water; and in the inſide of the top there are two pieces of a ſtrong hoop of the ſame kind, placed over each other in the form of a croſs at *b*. A ſtrong ring of braſs wire is ſoldered upon the outſide at *c*, that the jacket may be faſtened to it with an elaſtic bandage to prevent it from ſlipping downwards. At *d d* are the upper halves of the apertures for the arms; and *e e* are holes to afford light, and into which the eye glaſſes are ſcrewed; *f* is the opening

into

into which the mouth-piece of the breathing pipe is ſcrewed; and *g* is an aperture for looking through, as well as for the purpoſe of breathing when out of the water, and which, by means of the cover *h* ſuſpended from it, can be ſcrewed up before the diver enters the water.

Fig. 3 repreſents the under part of the cylinder, which is alſo 15 inches in height, and which at *i* and *k* is ſtrengthened by iron hoops on the inſide, in the ſame manner as the former. To the lower hoop *k* are ſoldered four ſmall rings, to which are faſtened ſtrong leather ſtraps, three inches in breadth, that can be buckled croſs-wiſe over the ſhoulders, and ſupport the whole machine; *l l* are the under halves of the apertures for the arms; *m* is alſo a ring of braſs wire ſoldered to the cylinder, which ſerves to keep faſt the jacket when buckled on, and to ſupport the upper cylinder (*fig.* 2) which ſlips over the under one, and on that account the under one is a little ſmaller ſo as to fit into the upper one. There is alſo another ſuch ring at *n*, in order to prevent the drawers from falling down.

At *o* (*fig.* 2, and *fig.* 6) is a ſtrong ſemicircular piece of iron, the uſe of which is to prevent the drawers, when preſſed by the water, from touching the under part of the body, otherwiſe the preſſure, even at the depth of ſix feet, would be inſupportable. As it is not poſſible to ſew the leather ſo cloſely as to prevent water from forcing its way through the ſeams, a ſmall pump is ſuſpended at *p*, for the purpoſe of pumping out the water when it has riſen to the height of a few inches in the lower cylinder. Four hooks *q q q q* ſoldered to the lower part of the cylinder are for the purpoſe of ſuſpending weights from them.

The jacket *r* (*fig.* 1) with ſhort ſleeves that cover the upper part of the arms, ſerves to prevent the water from penetrating through the joining of the cylinders, where the one is inſerted into the other, as alſo through the holes for the arms, as it is bound faſt round both parts of the cylinder

and

and likewiſe round the arms. The caſe is the ſame with the drawers, which are bound cloſe round the knees.

Fig. 4 repreſents a braſs elaſtic bandage, employed for faſtening on the jacket, and which, when hooked together, is ſcrewed faſt by means of the ſcrew *ſ*, three inches in length. A braſs bandage is here uſed, becauſe leather is apt to ſtretch, and on that account might be dangerous.

Fig. 5 is the mouth-piece to which the pipes *x y* are faſtened, and which is ſcrewed on at *f* (*fig.* 2); *t* is the ſcrew; *u* the part that goes into the machine, and which is taken into the mouth; *v* the exterior part of it, in which there is a partition *w* in order to ſeparate the pipes; and *z* is an aperture, that the air in the machine may communicate with the pipe *y*.

The internal diameter of theſe tubes is three fourths of an inch Rhinlandiſh. They conſiſt of ſtrong braſs wire $1\frac{1}{2}$ line in thickneſs, wound into a ſpiral form, and covered with ſtrong leather. In order to ſave expence, ſix yards of the pipe, from the mouth-piece, may be made in this manner, and the reſt of tubes of tin-plate three or four yards in length, joined together with pieces of leather-pipe about a foot in length, prepared in the firſt manner.

The reſervoir *a* (*fig.* 1), applied in ſuch a manner that it can be ſcrewed off, is for the purpoſe of collecting the ſmall quantity of water that might force itſelf into the breathing pipe when long uſed, and which otherwiſe would be in continual motion and render breathing diſagreeable.

To prevent the leather from becoming hard, and to cloſe up its pores, ſo that it may be rendered water-tight, the following mixture was rubbed over it: viz. 6 parts of wax, 2 of Venetian turpentine, 2 of pitch, and 2 of melted hogslard. It is alſo to be obſerved, that the beſt and ſtrongeſt leather muſt be uſed for the tubes, and that ſtripes of leather muſt be ſewed very cloſely on the ſeams of the jacket and drawers.

If

If the machine be intended for diving to a great depth, it muſt be conſtructed in as ſtrong a manner as poſſible, and the drawers muſt be furniſhed with iron ribs in the inſide faſtened by means of hoops to the machine, as may be ſeen fig. 3 and 6, over which a net of ſmall chains or ſtrong cords muſt be hooked or tied to the hoop *k*, and alſo to the hoops 2, 2, 2, 2, by means of the holes made in them for that purpoſe; but theſe chains or cords in particular which go behind muſt not be drawn too tight, that the diver may be able to bend his body.

The ribs 1, 1, are ſcrewed on the inſide to the ſtrong iron hoop *k*, but in ſuch a manner as to be moveable; and as the centres reſt on the hips, the diver can move his legs backwards and forwards. To theſe ribs the two hoops 2, 2, are made faſt by riveting at 3, 3, and the two interior ribs 4, 5—4, 5 are faſtened in the like manner. To the latter muſt be ſoldered at 5, 5, a circular piece 6, 6, 6, of the like radius as the part *c*, which, as the diver walks, moves backwards and forwards on *o* by means of a groove, at the ſame time that the outer ribs move; and on account of theſe ribs, hoops, &c. the preſſure of the water upwards will preſent the leſs impediment to the diver, as it can act only according to the diameter of the ſmalleſt hoops 3, 4—3, 4.

The author gives the following inſtructions for uſing a machine of this kind. When the diver, after being made acquainted with all the parts of the machine, has put it on and ſuſpended from it the proper weights, let him enter the water at any convenient place, and advance till it reaches to his eyes, while the end of the pipe is held by a perſon on the bank. If the diver can then breathe with eaſe, and if no water forces itſelf into the pipe, which muſt be left to float on the water, he may proceed till it covers his head, having firſt taken the precaution to tie a ſtrong rope to one of his arms. After this he may ſtop for ſome time, and then gradually go deeper and deeper, making ſignals that he finds himſelf at eaſe, by pulling the rope, or by ſpeaking through

the pipe. If a man exerciſes himſelf in this manner for ſeveral days ſucceſſively, ſtill increaſing his depth, he will ſoon be able to dive boldly, and to move under the water with eaſe and freedom: when he wiſhes to aſcend, he needs only unhook the weight, which will drop to the bottom; and being then lighter than an equal volume of water, he will riſe to the ſurface. To preſerve the weight from being loſt, a particular rope muſt be employed, which may be let down to the diver upon his making a certain ſignal, and which he may faſten to the weight before he unhooks it.

By following theſe directions a reſolute man may be taught, in the courſe of a few days, to dive to a moderate depth, though on account of various preparations and unforeſeen difficulties, the author employed five whole weeks in teaching one who was unacquainted with ſwimming. This man, called Frederick William Joachim, a huntſman by profeſſion, dived in the above apparatus into the Oder, near Breſlau, where the water was of conſiderable depth and the current ſtrong, on the 24th of June 1797, before a great number of ſpectators, and ſawed through the trunk of a tree which was lying at the bottom. He ſhewed alſo that he could have faſtened ſunk bodies to a rope in order to be drawn up, and that in caſe any impediments ſhould prevent the uſe of the ſaw, ſuch trunks might be hewn to pieces by an axe. It clearly appears, therefore, that two men furniſhed with ſuch apparatus could ſaw to pieces large beams of wood lying at the bottom of rivers, which are often a great obſtruction, and, on account of their ſize, cannot be otherwiſe removed.

One part of the conſtruction was attended with an inconvenience, which it may be proper to mention. It has been already remarked, that a man at the depth of five feet under the water cannot breathe without a machine; and though one, ſuch as that above deſcribed, will defend his breaſt and body from the preſſure of the water, yet though it be furniſhed with a pipe to breathe through, it will appear,

from what follows, that this will be impoſſible. The air which ſurrounds the diver in this machine amounts to ſomewhat more than a cubic foot. Now if he inhales air through the pipe ſcrewed to the machine, his body muſt diſtend a ſpace equal to the volume of air inhaled, conſequently he compreſſes ſo much the air that ſurrounds him in the machine. But as this is impoſſible, on account of its too great reſiſtance, he does not obtain air ſufficient to ſupport life, and is almoſt in the ſame ſtate as if ſurrounded by water. To be convinced of the truth of this, let any one take a caſk, equal in content to one or two cubic feet; preſs his mouth againſt the aperture of it, and try whether he can without difficulty breathe back into it the air he has inhaled. A larger ſpace around the diver in the machine would make breathing eaſier, but would not render him ſufficiently eaſy to labour. The interior air in the machine, therefore, muſt be connected with the pipe deſtined for breathing, in order that it may be at freedom to dilate as his body is extended; and it is only by a conſtruction of this kind, as ſhewn at *z* in deſcribing fig. 5, that a man can breathe while incloſed in ſo ſmall a ſpace. The author, at firſt, had furniſhed his mouth-piece with a valve, that the air might be again exhaled through it; but this valve was ſo ill conſtructed that it conveyed the exhaled air into the pipe deſtined for breathing. As he found that this was attended with inconvenience, on account of the moiſture which adhered to it, he afterwards omitted the valve entirely.

The diver, therefore, muſt ſuffer the air inhaled through the mouth-piece *u* to eſcape through his noſtrils into the machine; and then the air in it will remain equally elaſtic. The next time he draws breath, the air in the machine will be forced out from it at *z* by the diſtention of his body. By theſe means he will be able to breathe freely and eaſily for a long time; and thus the chief difficulty is overcome.

We cannot better conclude our account of M. Klingert's

diving machine than by recommending it to the attention of that benevolent inſtitution which has been the mean, in the hand of Providence, of averting the tear of ſorrow from the eye, and inexpreſſible anguiſh from the heart, of many individuals who daily implore that the richeſt bleſſings of Heaven may be ſhowered down upon the HUMANE SOCIETY. The apparatus ſeems ſo well contrived in all its parts, as almoſt to preclude the poſſibility of improving it: yet there can be little doubt that by the ingenuity of Britiſh artiſts it might be ſimpliſied a little, and produced at ſo cheap a rate that the funds of the Society might be able to add ſuch machines to their other apparatus for ſaving people from drowning. If ſuch machines were depoſited at the places where accidents of this kind moſt uſually occur, and ſome perſons in the neighbourhood inſtructed in the uſe of them, how ſpeedily might the unhappy victim be often reſcued from death! How infinitely preferable would this be to dragging, and how much more certain in its reſult, ſince the diver, when under water, could look round him for his object, and proceed directly to the ſpot! For ſuch a purpoſe it would be adviſable to make the machine ſo large that it would require an extra weight, more than equivalent to that of a man's body in water, to ſink it: the diver, by unhooking the weight or weights, would then be enabled to aſcend to the ſurface of the water with the patient in his arms.

XII. *Obſervations on Fire Balls.* *By* F. C. FULDA. *Read in the Phyſical Society of Gottingen, December* 7, 1796. *From* Profeſſor GMELIN's Göttingiſches Journal der Naturwiſſenſchaften, *Vol. I. Part* 2.

NOTWITHSTANDING the great progreſs which the ſciences have made in the preſent century, and though our knowledge of the atmoſphere has, in particular, been much enlarged,

enlarged, we are ſtill far from being able to explain all its phenomena, eſpecially thoſe of the luminous kind, in a manner ſufficiently ſatisfactory to the cautious and reflecting philoſopher. Though many, in conſequence of the important diſcoveries made reſpecting the electricity of the clouds, imagine that they have found in the electric fluid, ſo widely diffuſed, a certain key to all diſtant phenomena of a ſimilar kind, yet the greater part of them as mere obſervations, and the explanations given of them as mere hypotheſes, muſt be left to the deciſion of poſterity. It would be uſeleſs, and perhaps it is impoſſible, to mention all theſe phenomena in any certain order; but the moſt ſingular of them are large fire-balls (*bolides*), which, on account of their importance in natural philoſophy, have in modern times excited univerſal attention *.

Reſpecting the origin and nature of theſe phenomena, which are but ſeldom ſeen, and always ſurpriſe us as it were accidentally, we can venture conjectures and explanations only when we have compared a ſeries of obſervations carefully made with the circumſtances by which they were at-

* On the 13th of July 1797, about 42 minutes after nine in the evening, I had the good fortune, when in company with ſeveral of my friends, to ſee a meteor of this kind. It appeared in the ſouthern part of the horizon, at the height of 8 or 10 degrees; had the form of a perfect globe or ſphere well defined at the edges, almoſt as large as the moon when at full, and proceeded in the ſpace of ſcarcely a ſecond, while its courſe was only marked by a fine white ſtreak of light, in an almoſt perpendicular direction towards our horizon, which was confined by houſes, and diſappeared behind them. Its colour and ſplendour near the middle were ſometimes of a dazzling white. The heat during the day, and in the evening, was conſiderable. The thermometer varied from 18 to 20 of Reaumur, and between the hours of four and five in the afternoon there had been a ſtorm in the ſame quarter of the heavens. At the ſurface of the earth there was a perfect calm, and in the evening the weather-cocks ſhewed that a light ſouth-weſt wind prevailed at ſome height in the atmoſphere. At the time of this phenomenon the earth was overſpread by a pale miſt, through which no ſtars could be perceived, and which the following night became a thick fog.

tended, and have then deduced from them general concluſions *, which in the hands of the mathematician may conduct with the greateſt certainty to a knowledge of their nature, and of the cauſes by which they are produced. I ſhall endeavour, therefore, to preſent the reader with ſuch concluſions drawn from a ſeries of obſervations made in regard to fire-balls, not with the intention of giving any explanation from them myſelf, but in compliance with the excellent rule laid down by Le Roy, when he ſays, ſpeaking of this circumſtance: "Let us always collect obſervations without being too forward to deduce conſequences from them, and to explain phenomena reſpecting which we have at preſent ſo little knowledge †.

Some of the obſervations here given, as well as the concluſions drawn from them, have been already employed by Dr. Chladni, in a particular treatiſe ‡ to explain the origin of the maſs of iron found by Profeſſor Pallas in Siberia §, and other maſſes of the like kind, as well as ſtones which, according to accounts worthy of credit, are ſaid to have fallen from the heavens, and therefore more in a geological than a meteorological view. My object is quite different. I propoſe, notwithſtanding the difficulty of determining properly from the obſervations made to what claſs of luminous appearances ſuch phenomena belong ‖, to collect together thoſe accounts which have been conſidered, at leaſt with ſome proba-

* Il faudroit etudier avec ſoin les rapports de ces *phénomènes* avec les autres phénomènes atmoſphériques; rechercher l'état du ciel avant et après leur apparition, déterminer les tems, les circonſtances et lieux ou ils ſont les plus communs, ſavoir pourquoi ils ſont rares, et pourquoi ils arrivent. Que d'obſervations à faire! Que d'obſervateurs à occuper!—*Sennebier.*

† Memoires de l'Academie des Sciences, 1771.

‡ Ueber den Urſprung der von Pallas gefundenen und anderer ihr ähnlichen Eiſen-Maſſen, von C. F. F. Chladni. Riga 1794.

§ See Philoſophical Magazine, Vol. II. p. 1.

‖ Henry Barham, as mentioned in the Philoſophical Tranſactions, vol. xxx. p. 837, ſaw in Jamaica, in the year 1700, a flaming fire-ball, of the

ſize

probability, as alluding to the ſame kind, and in moſt caſes juſt as they were given by the obſervers, without paying attention to any particular mode of explanation, in order to aſſiſt thoſe whoſe attention is occupied with the origin and nature of theſe bodies, to examine the old and new hypotheſes formed reſpecting them, or to ſupport future ones, if neceſſary. Theſe meteors appear, then,

1. In every climate. Of fifty obſervations with which I am acquainted, three were made immediately under the equator *; three in a ſouthern †, and 44 in a northern latitude: and this diſproportion ariſes merely from the greater number of accounts brought to us from the latter, and the greater attention of the obſervers; for we are aſſured by Forſter, that he ſaw ſeveral fire-balls in the ſouth ſeas ‡.

2. At every ſeaſon of the year. I am acquainted with obſervations made in every month except September; and of theſe ſeveral were made, but between the 45th and 55th degree of northern latitude, in all the months except April,

ſize of a bomb, deſcend towards the earth; but though the ground was dug up around the place where it ſeemed to fall, nothing could be perceived except burnt graſs and a ſulphurous ſmell. A violent ſtorm, it is ſaid, had taken place a little before, which makes it highly probable that this phenomenon was nothing elſe than lightning, eſpecially as Reimarus relates, that lightning has been ſeen to fall upon houſes and conductors in a globular form, and that a ſulphureous ſmell has been afterwards perceived: ſee *Reimarus vom Bliz*, Hamburg 1794, p. 51, 155, 319. An obſervation of two balls proceeding towards each other before a thunder cloud, made by Hartman, in July 1758, ſeems to be of the like kind. See *Verwandſchaft der Elektriſchen Kraft mit den Luſterſcheinungen*, Hanover 1759, p. 237; and alſo a flaſh of lightning mentioned by Reimarus, p. 12. Other inſtances of the two phenomena being confounded, are noticed by Dr. Chladni in his work, p. 2.

* Ulloa's Voyage to South America. Lond. 1760. Vol. i. p. 354, and vol. ii. p. 226.

† Journal des Obſervations Phyſiques, Mathematiques et Botaniques, par Louis Feuillé. Paris 1714. Vol. i. p. 116, 119. and vol. iii. p. 92.

‡ Forſter's Obſervations, made during a voyage round the world, on Phyſical Geography, &c. p. 119.

June and September. It cannot, therefore, be ſaid that, like ſtorms, they appear more frequently at one time of the year than another.

3. At every period of the day. The hour when theſe phenomena took place is not indeed given by every obſerver, but obſervations have been made both by night and by day. The greater part, however, have been made in the evening, when, being more perceptible to the eye, it was leſs poſſible for them to eſcape notice.

4. They appear, for the moſt part, when the ſky is ſerene. This remark is expreſsly made in regard to 26 of the above mentioned 50; and in regard to the reſt it is to be concluded from concomitant circumſtances, ſuch as their height, &c. The heavens were often covered only with a pale miſt *, and ſome few were ſeen to proceed from light clouds †, which gives us reaſon to ſuppoſe that they came from a greater height than theſe clouds.

5. Moſt of them were ſeen to move with a very rapid motion, and of thoſe on the velocity of which obſervations have been made, that is ſaid to have moved quickeſt which was ſeen in the month of November 1758, and which, according to the calculation of Sir John Pringle ‡, paſſed over thirty Engliſh or ſeven German miles in one ſecond; a velocity greater by $3\frac{1}{2}$ miles in a ſecond, than that of the motion of the earth in its orbit. The one ſaid to have moved ſloweſt is that which was ſeen by Balbus at Bologna, in the month of March 1719 §, and which proceeded, according to his reckoning, at about 1530 feet or 0,067 of a German mile in one ſecond. But there is reaſon to conclude

* Breſlauer Sammlungen von Natur-und Medicin-Geſchichten. III. Jan. 1716, p. 544. Hanov. Magazin 1791, p. 1628.

† Breſlauer Sammlungen xxix. Aug. 1724, p. 169. Compare Lichtenbergs Gothaiſches Magazin, vol. iii. part 2. p. 92; vol. iv. part 2, p. 164.

‡ Philoſoph. Tranſactions, vol. li. part 1. p. 218.

§ De Bonon. Scient. Inſtit. Comment. vol. i. p. 285.

that

that the movement of others*, the courſe of which, as might be conjectured from their long train, was not in the direction of the eye, muſt have been much ſlower. Some appear alſo, unleſs theſe be refuſed a place here, to be peculiar to one part of the heavens †.

6. They proceed from, as well as towards, all points of the compaſs. The greater part of them, however, have beyond all diſpute appeared in the northern or ſouthern parts of the horizon; but no general concluſion, in regard to their connection with the northern ‡ or ſouthern lights, can be drawn from this circumſtance, though ſome obſervations made in Sweden § ſeem to favour ſuch an hypotheſis.

7. They do not always move according to the direction of the wind. The third obſerved by Ulloa makes, perhaps accidentally, an exception; and the ſpindle-ſhaped meteor ſeen by M. Lichtenberg, at Gottingen, on the 12th of November ‖, was towards the S. S. E. the then direction of the wind, which however near the earth was very little felt. Beſides, their velocity was ſeldom or never proportioned to that of the wind; as during the moſt violent ſtorm it does not move above 100 feet per ſecond. When ſuch meteors have appeared, it has been generally calm; but ſome of them were followed by wind ¶, and Forſter obſerved that after each fire-ball which he ſaw a violent wind took place.

* Breſlauer Sammlungen, iv. May 1718, p. 1077; Philoſoph. Tranſactions, vol. xliii. No. 477, p. 524; and Gothaiſches Magazin, vol. iv. part 2. p. 164.

† Hof in Acta Litteraria et Scient. Sueciæ, an. 1734, p. 78; and De Genſſance in Hiſtoire de l'Acad. des Sciences. Paris 1738. p. 36.

‡ Bergman's Phyſic. Beſchreibung der erdkugel, vol. ii. p. 78. Bernſtoff in Rozier's Journal de Phyſique, 1784, p. 115; and Blagden in the Philoſoph. Tranſactions for 1784, p. 229.

§ Hof and Celſius in Acta Litteraria et Scient. Sueciæ, an. 1734, p. 78 and 81. Giſler in Schwediſche Abhandlungen, vol. xxv. p. 65.

‖ Hannövriſches Magazin, 1791, p. 1626.

¶ Acta Litteraria Sueciæ, 1734, p. 78; and Chladni in Gothaiſches Magazin, vol. xi. part 2. p. 112.

8. They almoſt all fell towards the earth, and conſequently from a rarer to a denſer atmoſphere, as in moſt caſes might be concluded from their ſoon becoming conſiderably enlarged. Some of them, however, particularly thoſe which moved ſlowly, ſeemed to proceed in a horizontal direction over the ſurface of the earth; but none of them, according to every appearance, moved upwards. Their motion, therefore, cannot be explained in the ſame manner as that of ſky-rockets *, where the ſuperior air is rarified by the flame, and that below condenſed.

9. Their form was ſometimes perfectly globular, and ſometimes more ſpindle ſhaped; ſo that their length often occupied ſeven or eight degrees of the heavens. When obſerved to move with great velocity, they had a long tail behind, which aroſe chiefly from the continuance of the impreſſion made on the eye †. Others, however ‡, and particularly thoſe which moved ſlowly, ſhewed that a part of the tail belonged to the body itſelf; and it would appear that the long train which marks their courſe, ought often to be explained rather by traces left behind them than by mere impreſſion §.

10. Their apparent magnitude was very different, but on ſeveral occaſions greater than that of the moon ‖.

* Gothaiſches Magazin, vol. iii. part 2. p. 95.

† Intelligimus magis qua appareat ſtella, quam qua eat. Itaque velut igne continuo totum iter ſignat, quia viſus noſtri tarditas non ſubſequitur momenta currentis, ſed videt ſimul et unde exſilierit et quo pervenerit. Quod fit in fulmine, longus nobis videtur ignis ejus, quia cito ſpatium ſuum tranſilit, et oculis noſtris occurrit univerſum, per quod dejectus eſt. At ille non eſt extenti corporis per omne qua venit. Senecæ Queſt. Natur. lib. i. cap. xiv.

‡ Robinſon in the Philoſoph. Tranſactions for 1784, part i. p. 225.

§ Breſlauer Sammlungen, i. 1717. p. 157; Philoſoph. Tranſactions, vol. xli. part 2. p. 870, vol. xlii. p. 1; and Tranſactions of the American Philoſoph. Society, vol. ii. p. 173.

‖ Hiſtoire de l'Acad. des Sciences. Paris 1761. p. 28. Gothaiſches Magazin, vol. iii. part ii. p. 92.

11. Only

11. Only a few of them had an apparent motion round their axes*.

12. The greater part of them diffuſed a very lively dazzling light†; the fewer number a faint light. Their colour and ſplendour were very different and variable; ſometimes red, ſometimes blue, ſometimes violet, ſometimes in part yellow or dazzling white, and ſome exhibited the priſmatic colours‡. Several have been ſeen to burn with a bright flame, and others as if in a ſtate of ignition.

13. Their real diameter, as far as could be aſcertained, ſometimes by conjecture and ſometimes by actual meaſurement, was always very conſiderable. The diameter of that reſpecting which Sir John Pringle made calculations from various obſervations he collected, and of that ſeen by Mr. Rittenhouſe§ at Philadelphia, in the month of October 1779, were at moſt about half a German mile.

14. They ſeem to have originated at a very different, though moſt of them at a very conſiderable height above the ſurface of the earth. At any rate all of them, whoſe mean or greateſt height was ſubjected to any calculation, exceeded that of the higheſt clouds, as clouds are ſcarcely perceptible at the height of 13,500 toiſes; and Silberſchlag found the greateſt height of the fire-ball, which appeared in July 1762, to be 19 German miles, or 72,276 toiſes. On this account their origin, as Reimarus and Chladni have already ſufficiently ſhewn, is not to be aſcribed merely to electricity, though ſome have conſidered them as occaſioned by the action of the electric fluid between the clouds and the northern lights, which would agree exceedingly well with

* Nova Acta Nat. Curioſ. vol. i. p. 348. Theorie der am 23 ſten. Jul. 1762 erſchienenen Feuerkugel von J. E. Silberſchlag. Magd. Stend. u. Leipz. 1764. 4.

† Philoſoph. Tranſactions, vol. xli. part 1. p. 346.

‡ Gothaiſches Magazin, vol. iv. part 2. p. 164. Hannövriſches Magazin, 1791, p. 1627.

§ Tranſactions of the American Philoſoph. Society, vol. ii. p. 175.

their

their actual height; as, according to the meaſurement of Bergman, Kaſtner and Lambert *, the northern lights have an altitude of more than 20 or 30 German miles, and according to every appearance no fire-balls have been ſeen higher. On the other hand, this general concluſion led Halley †, Franklin ‡, and Rittenhouſe §, to the grand idea, which Dr. Chladni has defended with ſo much ingenuity, that theſe phenomena, as well as ſhooting ſtars, are coſmical meteors belonging to the atmoſphere of the ſun, which meeting our earth in its courſe round that luminary are inflamed, by ſome cauſe or other, when they enter the earth's atmoſphere. The phenomenon alſo ſeen by De Genſſance at Paris in the month of July 1738, and the like obſervation of falling ſtars on the higheſt mountains, as well as on the ſurface of the ſea ‖, but in particular the new diſtant luminous phenomenon obſerved by M. Schroter ¶, will appear the more favourable to this hypotheſis, as we have reaſon to ſuppoſe that there are proceſſes carried on in our atmoſphere with which we are as little acquainted as with thoſe carried on in the interior parts of the earth.

15. The time of their duration was very different: that obſerved by De Genſſance continued half an hour; at other times their duration has ſeldom been above a minute. Few or none of them, however, have been obſerved from the commencement of their appearance till the time when they diſappeared.

16. Many of them in their courſe threw out ſparks, and the greater part of them were ſeen to divide themſelves into ſeveral, ſometimes larger, ſometimes ſmaller parts, before they

* Göttingiſcher Taſchen-Calendar, 1778, p. 52.

† Philoſoph. Tranſactions, No. 341.

‡ Gothaiſches Magazin, vol. iv. part 2. p. 114; and vol. ix. part 3. p. 173.

§ Tranſactions of the American Philoſoph. Society, vol. ii. p. 175.

‖ Brydone in the Philoſoph. Tranſactions, vol. lxiii. part 1. p. 167.

¶ Gothaiſches Magazin, vol. xi. part 1. p. 86.

entirely

entirely diſappeared. This diviſion alſo ſeems to oppoſe the hypotheſis of a tract of inflammable air ſet on fire *, which Dr. Chladni has ſufficiently refuted on other grounds.

17. This burſting into pieces was for the moſt part accompanied with a rumbling noiſe like thunder, or a ſudden report. This was obſerved to be the caſe in regard to 27 of the 50 above mentioned; and very often two or more reports have been heard in ſucceſſion, without the large ball being divided into ſmaller ones, and without theſe being ſtill farther ſhattered. But as theſe reports were heard at a very great diſtance †, and as many which did not appear to be more remote, but nearer, have burſt without any report; a queſtion ariſes, whether we are to conſider, as Dr. Chladni does, this violent burſting as peculiar to all theſe phenomena?

18. Several, after burſting, ſeemed to diſſolve into ſmoke ‡, and, according to the obſervation made by Celſius in the month of March 1731, a viſible ſmoking ſtripe ſeemed to be previouſly inflamed. The greater part of them, however, after exploding, left no viſible traces behind.

19. In ſome caſes, after their diſappearance, a ſulphureous ſmell was perceived §, like that perceived after lightning has fallen, and which gave occaſion to Muſchenbroek's hypotheſis of an accumulation of ſulphureous inflammable vapours that ariſe from volcanoes and ſubterranean pits, and being driven together by the winds form clouds, that by ſome accident or other are ſet on fire; but which, however, can as little be reconciled with their general prodigious height, as Silberſchlag's oily and ſlimy vapours.

* Gehlers Phyſ. Wörterbuch, art. Feuerkugel.

† Allgem. Hiſtorie der Reiſen, vol. ix. p. 564; and Philoſoph. Tranſactions, vol. iii. part 1. p. 163.

‡ De Bonon. Scient. Inſtit. et. Comment. vol. i. p. 285; Philoſoph. Tranſactions, vol. xli. part 2. p. 870, vol. xlii. p. 1; and Hiſt. de l'Acad. des Sciences, Paris 1753, p. 73.

§ Breſlauer Sammlungen, i. p. 157; Philoſoph. Tranſactions, vol. l. p. 299; and Goth. Magazin, vol. xi. part 2. p. 112.

20. As ſcoriaceous maſſes have frequently been either actually ſeen to fall at the time of the diſappearance of theſe phenomena, or have been found ſoon after on the ſurface of the earth, and as it is ſufficiently proved by various accounts that ſtones have fallen from the atmoſphere, Dr. Chladni concludes that both theſe phenomena are connected; but this can be determined only by future accurate obſervations.

XIII. *A Communication from Mr.* W. H. PEPYS *jun. Member of the London Philoſophical Society, containing an Account of ſome intereſting Experiments on the Production of Artificial Cold, in one of which Fifty-ſix Pounds of Mercury was frozen into a ſolid Maſs.*

THE freezing or fixing of mercury has been the means of proving it to be a metal poſſeſſing the principal properties and characteriſtics of other metals, as ſplendour, malleability, and a cryſtalliſed ſtructure when reduced to a ſolid form. Gmelin was the firſt who ever obſerved mercury at ſuch a low temperature as leads to a belief that a partial congelation had taken place, though he did not then ſuſpect the fact; but "De L'Iſle was probably the firſt perſon upon earth who ſaw quickſilver reduced to a ſolid form by cold, and ventured to credit the teſtimony of his ſenſes*." This happened at Yakutſk in Siberia, in 1736, where the natural temperature was ſo low at the time as to produce the effect without the aid of artificial means.

Since that period the production of artificial cold, by means of various mixtures, ſufficiently intenſe to freeze mercury, has employed the abilities of the moſt experienced chemiſts and philoſophers, as Braun, Blumenbach, Hutchins, Lambert Bicker, Fothergill, Cazalet, Guthrie, Caven-

* See Dr. Blagden's paper on this ſubject in the Phil. Tranſactions for 1783.

diſh,

diſh, &c. and latterly Walker, who, in his treatiſe on that ſubject, ſeemed to have exhauſted the whole train of mixtures, and certainly has ſhewn conſiderable ingenuity in the contrivance of the inſtruments and apparatus he employed to accompliſh the end he had in view: but, though I am poſſeſſed of the principal part of them, and repeated his experiments with the greateſt care and attention, I cannot ſay I ſucceeded in all of them. The materials employed by Seguin for frigorific mixtures are certainly the beſt that have yet been propoſed, or perhaps can poſſibly be deviſed. Conſidering the muriats as a claſs of ſalts beſt ſuited for the purpoſe, and having tried them all, he gave the decided preference to muriat of lime in cryſtals. His method was to mix the cryſtals, previouſly pulveriſed, with an equal weight of uncompreſſed ſnow. My friends Allen and Lawſon were, I believe, the firſt who in this country tried that method: this was in December laſt; and they ſucceeded perfectly in freezing the mercury.

Determining to make the experiment with accuracy in reſpect to the weight of the materials employed, and on ſuch a ſcale that it might be repeated by any one, on the 30th of January laſt we collected a quantity of ſnow for the purpoſe. The temperature of the laboratory at the time was 40°. It may not be improper to mention here, that the thermometer employed in this and the other experiments which followed was filled with tinged alkohol, and accurately divided according to Fahr. ſcale, as mercurial thermometers cannot be reſorted to for determining degrees of temperature at or under the freezing point of that metal. Having put into an earthen pan equal parts of muriat of lime of the temperature of 40° and ſnow at 32° above 0°, we found that the temperature of the mixture, as ſoon as liquefaction took place, was 32° below 0°. Into this mixture we immerſed, each in ſeparate veſſels, 8 oz. troy of muriat of lime, and the ſame weight of ſnow, by which means, and with very little trouble, they were cooled down to 5° above 0°, the mixture

gaining

gaining a proportionate increaſe of temperature by the heat which had paſſed into it from the immerſed ſnow and muriat.

We now placed a half-pint Wedgewood's cup within a white ſtone-ware jar, inſulating it, agreeably to a method ſuggeſted by our friend Howard, with three corks placed at equal diſtances round the veſſel, and one at the bottom for the cup to reſt upon. This prevented the cup from coming in contact with the jar, which we now placed, with the cup in it, in the mixture that had ſerved for cooling the materials down to + 5° *, adding to the mixture a little more muriat of lime at + 40° and ſnow at + 32°. By this means we ſecured the advantage of having a cold atmoſphere within the jar all round the inſulated cup.

Upon mixing the cooled ingredients, which were now put into the cup, the thermometer, being immerſed in the mixture, ſunk to — 50°. Four ounces of pure mercury at + 40°, in a ſmall thin glaſs retort, were then introduced into this mixture, which in 15 minutes became perfectly fixed. We obſerved that it congealed from the circumference towards the centre, in the ſame way as wax or reſin fixes in cooling.

We now broke the retort, and gave the mercury ſeveral blows with the beak of a hammer, which indented, and at laſt fractured it: the fracture was ſimilar to that of zink, but with facets more cubical. Inadvertently taking up a piece of the ſolid mercury, I experienced a ſenſation as if I had received a wound from a rough-edged inſtrument. I threw it from me as I would have done a piece of red-hot iron, and was not a little alarmed when I found that the part of my hand which had been in contact with the metal, immediately after loſt all ſenſation, and became white and dead to the view.

The mercury in the mean time had become fluid. The time that had paſſed from taking it out of the mixture might

* The ſign + denotes above, and the ſign — below 0°.

have

have been about two minutes; but the accident that happened to my hand prevented me from noting it exactly. On trying the temperature of the mixture, I now found it $-42°$: the addition of ſome ſnow, which had been cooled for the purpoſe while the preceding experiment was going on, reduced it again to $-50°$.

We now put into the mixture a glaſs tube containing ſome mercury. In two minutes it was completely fixed. We broke the tube, and bent the cylindrical piece of mercury into an acute angle, by means of pincers: we attempted to ſtraiten it again, but it became fluid during the operation.

Several ſubſtances in proper veſſels were now tried in the cold mixture. Sulphuric ether exhibited no ſigns of congelation: rectified ſpirit of turpentine became thick and nearly conſiſtent at $-50°$: pure concentrated ſulphuric acid was fixed: acetic acid likewiſe was fixed: nitric acid became thick and ropy. On muriatic acid the cold had no effect.

On the 7th of this month (Feb.) we repeated our experiment, in the preſence of a number of our acquaintance, with the ſame ſucceſs as before.

Encouraged by the ſucceſs of theſe experiments, we reſolved to attempt one of ſome magnitude. Accordingly, on the following day, my friend Allen, who is a zealous and able chemiſt, ſtarted a bullion of mercury for the purpoſe; and, having weighed 56 lbs. avoirdupoiſe, we prepared every thing neceſſary for fixing this quantity.

The mercury was put into a ſtrong bladder and well ſecured at the mouth, the temperature of the laboratory at the time being $+33°$. A mixture conſiſting of muriat of lime 2 lib. at $+33°$ and the ſame weight of ſnow at $+32°$ gave $-42°$. The mercury was put as gently as poſſible into this mixture (to prevent a rupture of the bladder), by means of a cloth held at the four corners. When the cold mixture had robbed the mercury of ſo much of its heat as to have its own temperature thereby raiſed from $-42°$ to $+5$, another mixture, the ſame in every reſpect as the laſt, was made,

which

which gave, on trial with the thermometer, − 43°. The mercury was now received into the cloth, and put gently into this new mixture, where it was left to be cooled ſtill lower than before.

In the mean time five pounds of muriat of lime, in a large pail made of tinned-iron and japanned inſide and outſide, was placed in a cooling mixture in an earthen-ware pan. The mixture in the pan, which conſiſted of 4 lib. of muriat of lime and a like quantity of ſnow, of the ſame temperature as the former, in one hour reduced the 5 lib. of muriat in the pail to − 15°. The mixture was then emptied out of the earthen pan, and four large corks, at proper diſtances, placed on its bottom, to ſerve as reſts for the japanned pail which was now put into the pan. The corks anſwered the purpoſe already mentioned, that of inſulating the inner veſſel, while the exterior one kept off the ſurrounding atmoſphere, and preſerved the air between the two at a low temperature.

To the 5 lib. of muriat of lime which had been cooled as already noticed to − 15°, and which ſtill remained in the metallic veſſel, was now added ſnow, uncompreſſed and free from moiſture, at the uſual temperature of + 32°. In leſs than three minutes the mixture gave a temperature of − 62°: a degree of cold which I believe was never before produced in this country, being 94° below the freezing point of water.

The mercury, which, by immerſion in the ſecond cooling-mixture to which it was expoſed, we found by this time reduced to − 30°, was now, by the means employed before, cautiouſly put into the laſt-made mixture of the temperature of − 62°. A hoop, with net-work faſtened to its upper edge, and of ſuch a breadth in the rim that the net-work, when loaded with the bladder of mercury, could not reach its lower edge, was at the bottom of the mixture, to prevent the bladder from coming in contact with the veſſel; by which means the mercury was ſuſpended in the middle of the mixture. As ſoon as the bladder was ſafely depoſited on the net-work, the veſſels were carefully covered over with

a cloth, to impede the paſſage of heat from the ſurrounding atmoſphere into our materials. The condenſation of moiſture from the atmoſphere by the agency of ſo low a temperature was greater than could have been expected: it floated like ſteam over our veſſels, and, but for the interpoſed covering, would have given our mixture more temperature than was deſirable.

After one hour and forty minutes we found, by means of a ſearcher introduced for the purpoſe, that the mercury was ſolid and fixed. The temperature of the mixture at this time was -46, that is 16° higher than when the mercury was put into it.

We now regretted that we had not ſlung the hoop and net-work in the ſame way as the ſhell of a beam is ſuſpended, which would have enabled us to lift it out of the mixture at once with the bladder and its contents; but having overlooked this proviſion, we were obliged to turn out the whole contents of the pail into a large evaporating capſule made of iron, which was not effected without the mercury ſtriking againſt its bottom, and at the ſame time receiving a conſiderable increaſe of temperature. The bladder was now cut. The eagerneſs of our friends, of whom ſeveral were preſent, to be in poſſeſſion of pieces of the ſolid mercury, which had fractured by the fall it had received, was paſt deſcription. Forgetting, and perhaps not being aware of the conſequence, ſome ruſhed their hands into the frigorific mixture, while ſome ſeized on pieces which others, having ſelected with their eyes as their prize, alſo laid hold of at the ſame moment, and conſequently each graſped them harder than otherwiſe they would have done. The acute pain that inſtantly followed, quickly recalled their recollection, and, but for the ſufferings of the individuals, the ſcene would have excited no ſmall degree of mirth: ſome clapt their hands into their mouths, others ſhook them, blew on them, or rubbed them againſt their clothes; and all were more or leſs

alarmed at the dead appearance of the parts that had been ſo ſuddenly robbed of heat by the frozen metal *.

The larger pieces were kept for ſome minutes before fuſion took place, while others were twiſted and bent into various forms, to the no ſmall gratification and ſurpriſe of thoſe who had never witneſſed or expected to ſee ſuch an effect produced on ſo fuſible a metal.

Though mercury in the ſtate in which we had it, exhibited a conſiderable degree of ductility and malleability, we cannot thence infer the degree in which they would be found to belong to it, could it be reduced to a temperature much more conſiderably under its freezing point, which ſeems to be at about -39° or -40°. At the time that we bent and twiſted it, it may be conſidered as having been in a proportionate temperature to iron near its point of fuſion, when, as is well known, it will hardly bear the ſmalleſt blow of a hammer.

As the apparatus employed in theſe experiments was extremely ſimple, a ſhort deſcription of them may not be unacceptable. Fig. 1 (*Plate II.*) repreſents that employed in the firſt experiments; and only viewing the figure will con-

* It was a conſiderable time before ſenſation and the natural colour was reſtored to the parts, which however returned without any other means being employed than ſuch as have been mentioned. It is eaſy to conceive that the injury was little more than ſkin deep, like what takes place from touching a hot metal, without allowing it to remain long enough in contact with the ſkin to produce a wound; but what is very ſingular, almoſt every individual compared the ſudden pain he experienced to that produced by a *burn or ſcald!* One gentleman, who called accidentally while we were preparing for our experiment, but who had no acquaintance with the ſubject, not being able to conceive how the effect propoſed could be produced by the mixture, was deſired to take a little ſnow in one hand and muriat of lime in the other: "they were neither of them colder than he expected to find them:" then to put the ſnow into the hand that held the muriat. The ingredients had hardly come in contact when he threw them from him, exclaiming, "Cold!—'Tis a red-hot coal!"

vey to any one a complete idea of the arrangement, as it exhibits the retort containing the mercury, ſurrounded by the cooling-mixture in the half-pint cup, which is inſulated by means of the corks, and prevented from coming in contact with the ſtone-ware jar – the ſpace between the latter being occupied only with cold air, preſerved in that ſtate by means of the frigorific mixture in the exterior veſſel, and which ſurrounds the jar.

Fig. 2 repreſents the apparatus employed in the large experiment, which is ſimilar in its arrangement to the former; only that the cold atmoſphere round the japanned pail had no exterior cold mixture to defend it; which, however, was the leſs neceſſary, as the earthen pan was of conſiderable thickneſs, and had acquired the temperature of the mixture that had been employed in cooling the 5 lib. of muriat of lime.

In experiments of the kind I have deſcribed, all the exterior veſſels ſhould be of earthen-ware or wood, which being bad conductors of heat, prevent the ingredients from receiving heat from the atmoſphere and ſurrounding objects with the ſame facility that they would through metals; and, for a ſimilar reaſon, the interior veſſels are beſt of metal *, that they may allow the heat to paſs more readily from the ſubſtance to be cooled into the frigorific mixture employed for that purpoſe.

Muriat of lime is certainly the moſt powerful, and at the ſame time the moſt economical ſubſtance that can be employed for producing artificial cold; for its firſt coſt is a mere trifle, being a reſiduum from many chemical proceſſes, as the diſtillation of pure ammonia, &c. and often thrown away: beſides, it may be repeatedly uſed for ſimilar experiments, nothing being neceſſary for this purpoſe but filtration and evaporation to bring it to its firſt ſtate. The eva-

* When we uſed a glaſs-retort to contain the mercury, it was that we might be able to ſee ſuch phenomena as might preſent themſelves during its congelation.

poration ſhould be carried on till the ſolution becomes as thick as a ſtrong ſyrup, and upon cooling the whole will become cryſtalliſed: it muſt then be powdered, put up in dry bottles, well corked, and covered with bladder or cement, to prevent liquefaction; which otherwiſe would ſoon take place, owing to the great affinity the muriat has for moiſture.

The powerful effects produced by the frigorific mixture of muriat of lime and ſnow preſents a wide field for experiments to determine the poſſibility of fixing ſome of the gaſes by intenſe cold. As ſoon as an opportunity offers, we mean to attempt ſome experiments with that view, of the ſucceſs of which the earlieſt account ſhall be ſent to the Philoſophical Magazine, for the information of thoſe who are fond of ſuch purſuits.

XIV. *Letters from ſome of the Men of Science engaged in the French Expedition to Egypt.*

[Continued from Vol. II. page 417.]

LETTER III.

Cairo, Thermidor 26th.

I CONFORM to the manners of the Turks. We all wear whiſkers, becauſe a bare chin is a ſign of ſlavery; and, though we are here maſters, the force of prejudice makes the Turks believe that thoſe Frenchmen who appear without whiſkers are the ſlaves of the reſt.

I have juſt come from the Inſtitute of Cairo. Two palaces of the beys, and two other houſes, which belonged to rich individuals, all contiguous, ſerve to lodge the men of letters and artiſts. Theſe houſes afford us, perhaps, more convenience than is found at the Louvre, and, at leaſt, as much magnificence. An immenſe garden, the ſuperficial content of which is equal to thirty-five French acres, well planted, and having a number of raiſed terraces, which the

waters of the Nile, during the time of its inundation, never reach, is deſtined for botany and the cultivation of plants.

The hall where the Inſtitute meets is already decorated with the richeſt French furniture found in the houſes of the Mamalouks. Beſides other articles, there are, a very large fine clock by Berthout, and a Japan vaſe of great ſize.

I am juſt now employed in collecting all the curious animals, which I was told were to be found at the houſes of the Mamalouks. Our place for keeping birds is already completed; and in a little time we ſhall be better eſtabliſhed than if we were in the *Jardin des Plantes*. But the greateſt ambition of the members of the Inſtitute is to tranſmit to you the firſt volume of our memoirs, before thoſe of the French Inſtitute ſhall appear. We are labouring for this purpoſe with great aſſiduity. You will find two memoirs of mine, which I hope will meet with your approbation.

I wiſh to give you ſome details, particularly in regard to what I have obſerved in this country; but too many events have taken place, and I ſee ſo many things highly intereſting to the philoſopher that I really am at a loſs what to ſay or where to begin. I ſhall, therefore, give you an account only of a breakfaſt and dinner in which I participated, as they will ſerve to convey ſome idea of the manners of the Egyptians.

General Menou, being proviſional commandant of the province of Roſetta, was deſirous of making a tour through it; and as there are no inns here, and as he was informed, beſides, that it is cuſtomary for the commandant to accept a dinner from the chief of the canton, the general conformed to that uſage. We accompanied him, to the number of fifteen, and had a guard of twenty ſoldiers. Ninety-ſix diſhes, all touching each other, and diſpoſed in the form of an ellipſe, were ſerved up, on the ground, which was covered, however, with mats and carpets. We were treated in a high ſtyle. The entertainment did not conſiſt of ſeveral ſervices, but, what amounts to the ſame thing, of ſeveral

ſtories. The largeſt articles were in diſhes of a proportionate ſize. All theſe diſhes occupied the lower part: they were of a circular form and made of tin, as in France. Three diſhes, placed quite cloſe to each other, left an empty ſpace in the middle, which was entirely concealed by a ſmaller diſh. Theſe diſhes contained the dainties, which are made by the real Egyptian women. The company firſt attacked theſe in order to get rid of them, and that they might have acceſs to the lower range. Theſe dainties conſiſted of ſeven or eight kinds of cheeſe, molaſſes baked with flour paſte, fricaſſes of rice and mutton baked with raiſins, prunes, figs, grenadilloes, &c.

The ſolid diſhes were fowls dreſſed with rice, or prepared other ways, &c. The ellipſis forming the whole of the ſervice was bordered with half a cubical foot of bread of twelve kinds and different forms: there were cakes of various ſorts, elliptic and circular bread, &c. &c.

The Cheik invited us all to ſquat down around, and we ſoon ſaw the Turks in the company put their hands into the diſhes, take the liquids in their palms and the ſolids in their fingers, and in that manner convey them to their mouth. We were obliged to do the ſame; for we had neither ſpoons nor forks.

The dinner, which we partook of in a neighbouring village, was not much different from our breakfaſt, except by the abſence of milk diſhes, and a leſs variety in the kinds of bread. The new diſhes were, a whole ſheep in the middle, and various other viands around, either roaſted or fried in a very whimſical manner. The principal domeſtic, who waited on us, croſſed the ſervice through a paſſage which he made by taking away ſome of the diſhes. When he cut up the ſheep, he divided it into pieces by means of his hands and a knife, or broke and tore it without much ceremony, and diſtributed a part to each.

The Cheik who entertained us at breakfaſt had a ſon 34 years of age, a rich farmer, and, next to his father, the moſt

conſi-

conſiderable man in the village. We wiſhed this young man's ſon to breakfaſt with us, and we deſired him to place himſelf at table; but he bluſhed as if we had aſked him to commit a crime. His father told us that his child would never be prevailed on to ſit down where his grandfather ſat, and above all to eat in his preſence: that the profound reſpect he entertained for his grandfather, made him impoſe this on himſelf as a law. We then invited the ſon to ſit down; but he made the ſame obſervations in regard to himſelf, and with a religious ſolemnity which ſurpriſed us. General Menou requeſted the grandfather to order his children and grand-children to partake in the entertainment; and after ſome heſitation he agreed, ſaying, that it was contrary to cuſtom, but that it gave pleaſure to his paternal heart. The children obeyed; but they had an air of reſerve and timidity during the whole time they were eating. They made haſte to finiſh their meal, and retired ſpeedily according to the cuſtom of the country, which requires thoſe who have no appetite to depart.

After General Menou and his company had finiſhed their repaſt, the ſoldiers came, in their turn, to feed upon what we had left. The firſt, and this ſecond company, who conſiſted of jolly fellows of a keen appetite, ate at moſt two thirds of what had been ſerved up, after which the poor of the village were invited. Theſe regaled themſelves with what remained. They entirely emptied the diſhes, for which they contended, and which they tore from each other in a manner that afforded us much amuſement.

Theſe Cheiks behaved with ſo much liberality only becauſe they are authoriſed by the laws of the country, when a commander in chief takes a repaſt with them, to reimburſe themſelves for the expence they have been at, by an impoſt which they levy immediately; and as it is therefore the village which treats, the inhabitants have a right to partake in the feaſt, and to eat up what remains on the table of their lord. But thoſe who actually pay do not participate in the

entertainment: the poor in all countries eſcape ſuch aſſeſſments, and people who are in eaſy circumſtances diſdain to go and eat fragments.

Upon the whole, the Egyptians in the country are exceedingly miſerable: ſo much ſo indeed that the imagination can hardly conceive it. Would you believe that the greater part of the villages conſiſt almoſt entirely of earthen huts, which are not three feet in height; that the aperture through which theſe miſerable creatures enter their kennels is a circular hole of a foot and a half diameter, and that this hole remains always open; that there is no room in theſe huts, but what is neceſſary for the huſband, wife and children, all huddled together, to ſleep upon; and that, to enter theſe wretched habitations, they are obliged to creep on all fours? A place built up of earth, on which they bake their bread, occupies the third of the hut; two ſtones to grind corn, a coffee-pot to make coffee, and a bag containing tobacco, are all the furniture of theſe poor peaſants. They never eat fleſh, but they all drink coffee in the morning. The Turks cannot live without coffee and tobacco. Beſides theſe, they ſeem to be acquainted with no wants. They drink their coffee without ſugar, and with the grounds: the more abundant the latter are, ſo much the more agreeable it is to their taſte.

LETTER IV.

Cairo, Fructidor 11.

THE members of the National Inſtitute have founded here an eſtabliſhment like that of Paris. They have aſſociated with them ſome of the men of letters and artiſts who followed the army, and ſome military men have been admitted members alſo. Generals Kleber, Deſſaix, Regnier, Andreoſſi and Cafarelli; Salkowſki aid-de-camp to the commander in chief, and Sucy chief commiſſary, have been likewiſe admitted. This eſtabliſhment has a very beautiful ſituation, and in a little time we ſhall have a botanical garden. A menagerie has already been begun to be formed,

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and there will ſoon be a public library, an obſervatory, a cabinet of philoſophical inſtruments, a chemical laboratory, a hall of antiques, &c. Citizen Monge has been elected preſident; the Commander in chief, vice-preſident; and Cit. Fornier, ſecretary.

XV. *On the new Inſect ſo prejudicial to Apple Trees; and a Method for extirpating them.*

WITHIN theſe few years an inſect, before unknown in this country, has made its appearance in the Britiſh orchards, which, if means are not generally taken to root it out, will in a ſhort period deſtroy every apple tree in the kingdom. It exhibits upon the trees the appearance of a white efflorescence, like what may be ſometimes ſeen on ſtones in the fields: this ſeems, however, to be only the habitation of the inſects, which exiſt in millions wherever they have once lodged themſelves. On bruizing the efflorescence-like matter between the fingers, a deep red-coloured fluid like blood is expreſſed, and which probably is of that nature. Already have ſeveral valuable orchards been much injured by this inſect, which corrodes the apple trees in ſuch a manner as at laſt completely to deſtroy their organization and to kill them, without the proprietors, many of them at leaſt, even once ſuſpecting the cauſe. We hope what we now ſtate will be the mean of making the fact generally known, and of inducing every perſon intereſted to co-operate in rooting them out.

We are happy in having it in our power to give them the recipe of a cheap compoſition diſcovered by William Forſyth, Eſq. his majeſty's gardener at Kenſington, which has been found effectually to anſwer the purpoſe. It is as follows:

℞. To 100 gallons of human urine add as much cow dung as will bring the whole to the conſiſtence of paint, with which anoint the infected trees about the end of March.

XVI.

XVI. *Second Communication from Dr.* THORNTON, *Phyſician to the General Diſpenſary, relative to different Trials made with the Factitious Airs.*

SIR, Feb. 20. Duke-ſtreet, Groſvenor Square.

I AM happy to inform you that I have been honoured from the moſt reſpectable quarters with ſeveral communications for your Magazine, relative to Pneumatic Medicine. Permit me to mention, that the only inducement I have for publiſhing in your work, is the great eſtimation I hold it in, the good of my fellow creatures, and a wiſh to fill up the chaſm from the laſt publications by Dr. Beddoes on the Factitious Airs, until the eſtabliſhment of a Pneumatic Hoſpital, the foundation of which is begun to be laid by that enlightened and patriotic phyſician, when the ſubject, he ſays, will be again revived by him. I am, ſir,

To the Editor of the Philoſophical Magazine. } Your obedient ſervant, ROBERT JOHN THORNTON.

A REMARKABLE CASE OF SCROPHULA CURED BY VITAL AIR.

Miſs Holmer, at 18, an amiable and accompliſhed young lady, the daughter of a wholeſale ironmonger in the Borough *, ſo early as at the age of ſeven had the glands of the neck beginning to take on diſeaſe. Firſt one gland under the ear, then another, and by degrees all the glands about the neck became enlarged, and went on gradually increaſing. The ſame diſpoſition alſo ſhewed itſelf by an affection of the eyes, for which this lady was nine months under the care of Mr. Ware. During the progreſs of glandular affection, ſhe was under Meſſrs. Kent, Fearon, Bayley,

* This lady had all the benefit of country air; her father having a houſe at Vauxhall, and keeping his carriage, ſhe had every advantage that fortune could give her. EDIT.

&c.

&c. &c. and Dr. Saunders. Mercury was uſed externally and internally until the teeth became looſened, bark, and ſteel, and ſoda, or foſſil alkali, given in profuſion; but each practitioner in turn relinquiſhed the caſe, recommending ſea air, which was had recourſe to at ſundry times. This young lady was latterly referred to John Hunter, who employed hemlock to an uncommon extent; and he alſo, as the ſea air had been before tried without advantage, adviſed the parents to do nothing farther, ſaying, with his uſual bluntneſs, that it was a caſe of that nature that whoever would undertake the cure would do it only with the intent of picking their pockets. When I firſt ſaw the young lady, I obſerved the glands of the throat, even from the nape of the neck, ſo enlarged as to defeat all concealment, and forming one apparently hemogeneous maſs, extended even over the jaw-bones, which could not be felt, and ſuffocation was threatened by preſſure on the wind-pipe. Her relations ridiculed the idea of any farther application for this diſeaſe: but parental fondneſs urged an enquiry relative to the airs. The Rev. Mr. Townſend, rector of Pewſey, author of a very excellent work on phyſic, the Guide to Health, happened to be at my houſe when the lady arrived. Although he conceived highly of pneumatic medicine, as may be ſeen throughout this work, he told me, that he muſt conſider me as very bold if I could venture to undertake ſuch a caſe, which he acknowledged to exceed any thing he had ever before ſeen; and Mr. Jones, an eminent apothecary in Mount-ſtreet, declared, that if I produced a cure here, all he could ſay was "that *miracles* had not ceaſed." I, however, was not diſcouraged, and the event has proved that we ſhould not, having ſuch new and powerful agents as the airs, readily give way to deſpair.

In a month after commencing the inhalation of vital air (ſix quarts daily mixed with thirty of atmoſpheric), the knot of glands began to ſoften, yielding a little to external preſſure: by degrees they ſeparated from each other, and thir-

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teen glands could be diſtinctly made out; the jaw-bones became liberated; and theſe, whether from preſſure of the glands, or imperfect oſſification, were bent up a little from their natural courſe; and, not to tire the reader, I ſhall finally remark, that in leſs than eight months the decreaſe was *five inches by meaſurement round the neck!* The hands, which before were unuſually cold, were comfortably warm during the whole time the vital air was inhaled, and the appetite and ſpirits increaſed. Mr. Cruickſhank obſerved, that during the time of inhaling the ſuperoxygenated air, the pulſe were raiſed about ſix beats in a minute, and became ſtronger. I muſt beg leave to mention here, that I alſo rouſed the abſorbents by both topical as well as internal remedies. But why I place ſuch a ſtreſs on the power of the vital air over this ſyſtem of veſſels, is, that from the experiment of Dr. Beddoes, which he made upon himſelf, while inhaling a ſuperoxygenated air, he became, he obſerves, conſiderably diminiſhed in bulk, although he eat twice as much as before, which I conceive could only ariſe from the ſuperior energy given to the abſorbents by the vital air:—But, however the wiſe ones, paſt the age of forty, may ſmile at *theory*, the *fact* or cure muſt remain undoubted, and it is intended to lay others (many of which are no leſs remarkable) in quick ſucceſſion before the impartial tribunal of the philoſophic world.

XVII. *Biographical Memoirs of* JAMES BERNOULLI. *From the* New Tranſactions of the Imperial Academy of Sciences at Peterſburgh.

JAMES BERNOULLI, licentiate of law, member of the Phyſical Society of Baſle, and correſpondent of the Royal Academy of Sciences at Turin, ſon of John Bernoulli, L.L.D. Profeſſor of Mathematics in the univerſity of Baſle, and of Suſannah Koenig, was born in that city on the 17th of October

October 1759. Deſcended of a family rendered illuſtrious by three geometricians of the firſt claſs, and four other mathematicians of great reputation *, he diſtinguiſhed himſelf early by his talents and genius, improved by uncommon aſſiduity and great application to ſtudy. Having finiſhed his courſe of humanity, he was ſent to Neufchatel to learn the French language, as is cuſtomary at Baſle; and on his return, being admitted to the degree of maſter of arts, he entered his name as a ſtudent in law, and attended the lectures of the profeſſors of law in that univerſity with ſuch ſucceſs, that, in 1778, he found himſelf in a condition to

* 1. James Bernoulli, profeſſor of mathematics at Baſle, member of the academies of Paris and Berlin, born at Baſle the 27th of December 1654, died there Auguſt 16, 1705.

2. John Bernoulli, brother of the preceding, profeſſor of mathematics at Groningen, and afterwards at Baſle, member of the academies of Peterſburgh, Paris and Berlin, of the Royal Society of London, of the Inſtitute of Bologna, &c. born at Baſle, July 27, 1667; died there Jan 1, 1748.

3. Nicholas Bernoulli, nephew of the two preceding, profeſſor of mathematics at Padua, afterwards profeſſor of logic and then of law at Baſle, member of the Academy of Sciences and Belles Lettres at Berlin, member of the Royal Society of London and the Inſtitute of Bologna; born at Baſle, October 10, 1687; died there November 29, 1759.

4. Nicholas Bernoulli, ſon of No. 2, licentiate of law, profeſſor of law at Berne, and afterwards profeſſor of mathematics at Peterſburgh, member of the Inſtitute of Bologna; born at Baſle, January 17, 1695; died at Peterſburgh, July 26, 1726.

5. Daniel Bernoulli, brother of the preceding, M.D. profeſſor of mathematics at Peterſburgh, afterwards profeſſor of anatomy and botany at Baſle, and then profeſſor of natural philoſophy in the ſame, member of the Academy of Peterſburgh, Paris and Berlin, and of the Royal Society of London; born at Groeningen, January 29, 1700; died at Baſle, March 17, 1782.

6. John Bernoulli, brother of the two preceeding, L.L.D. profeſſor of eloquence, and afterwards of mathematics at Baſle, member of the Acad of Paris and Berlin; born at Baſle, May 18, 1710; died there, July 17, 1790.

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ſupport public theſes on ſome very difficult points of law, and to receive his licence.

In 1780 he made a tour through ſeveral cantons of Swiſſerland in company with a few friends. The account of this ſhort excurſion, written in a plain manner, and without the name of the author, may be found in the third volume of the collection of travels publiſhed at Berlin by M. John Bernoulli.

The ſtudy of the law, and the application he gave to that branch of knowledge, was not able to extinguiſh his geometric ſpirit hereditary in the family. The leſſons which had been given him by his father in his youth, and which were afterwards continued by his uncle, the celebrated Daniel Bernoulli, had increaſed his innate and irreſiſtible propenſity to the mathematical ſciences. His rapid progreſs inſpired him with the moſt flattering hopes, and induced the heads of the univerſity to entruſt him, in 1780, with the functions of his uncle, whoſe age and infirmities had rendered him incapable, for ſome time, of continuing his lectures on experimental philoſophy. Mr. Bernoulli diſcharged theſe functions, till the death of his uncle, to the ſatisfaction of his auditors and the univerſity; but he had not the pleaſure of ſucceeding to the vacant chair, though his name was inſerted in the liſt of candidates, becauſe academic places at Baſle are determined by lot, as well as all the other offices of the republic; and, on this occaſion, the lot was unfavourable to him, a caprice of fortune which he had experienced in 1780, when he ſtood candidate for the chair of eloquence, at that time vacant. It was on this laſt occaſion that he publiſhed his Theſes on the Sublime. This double diſappointment, joined to a ſtrong deſire of ſeeing the world, ſo natural and ſo powerful in young men, made him ſoon after form a reſolution, agreeable to his prevailing taſte for travelling, but which ſeemed likely, for a little time, to lead him aſide from the literary career he had entered with ſo much applauſe; and he ac-

cepted the place of ſecretary to Count de Breuner, miniſter of the Imperial Court of Vienna to the Republic of Venice.

This office furniſhed him, indeed, with the wiſhed-for opportunity of travelling, and of ſeeing ſucceſſively a great part of Germany and Italy; but he could not travel always, and when he arrived at the place of his deſtination he became tired of a manner of life ſo little conformable to his way of thinking, and unfavourable to his taſte for ſtudy. The ſociety of a ſmall number of literary men, and particularly of ſome geometricians of reputation, with whom he formed an acquaintance in Italy, and who received him in a manner ſuited to the name he bore, and to his perſonal merit, rendered his ſituation comfortable for ſome time. The friendſhip of theſe diſtinguiſhed characters, among whom was the celebrated Lorgna, gave an agreeableneſs to his reſidence in that country, of which he long preſerved a remembrance; but it could not extinguiſh the deſire of ſoon finding a place where he might devote himſelf entirely to the mathematical ſciences, and make uſe of the knowledge he had acquired in them, and of which he had given public proofs in the Memoirs of the Royal Academy of Sciences and Belles Lettres at Berlin, and in thoſe of the Royal Society of Turin, who received him among the number of their correſponding members, during his reſidence in the latter city.

The diſpoſition of mind above mentioned having, by means of John Bernoulli at Berlin, come to the knowledge of his countryman Mr. Fuſs, the latter embraced a favourable opportunity of mentioning him to the princeſs of Daſchkaw; and her excellency being already diſpoſed to repair the loſs which the Academy of Peterſburgh had ſuſtained by the death of Mr. Lexell, found that Mr. Bernoulli, independently of his perſonal merit, had a diſtinguiſhed right to aſpire at a place in an academy to which, ſince its foundation, his grandfather and two grand uncles had rendered eſſential ſervices. Bernoulli, therefore, received

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the vocation of an adjunct, with a salary of 600 rubles, and the promise of being promoted in the course of a year. He accepted these offers with joy, and quitted Venice in the month of May 1786, taking the route of Switzerland to revisit his country and family before he went to Russia, where he was to establish himself, in consequence of his engagement, for at least three years.

Scarcely had he reached Petersburg when his ruling passion for travelling, or, what amounts to the same thing, his desire of acquiring knowledge, made him conceive the idea of participating in a sea voyage planned at that time, and for the execution of which several vessels, destined to sail under the command of M. Moulouski, were then fitting out. Mr. Bernoulli ardently wished to have a share in this expedition as astronomer, and conversed on that subject with the chief of the expedition, who received the proposal with pleasure, and promised to get the conditions they had agreed on sanctioned; but Mr. Bernoulli's friends induced him, though with great difficulty, to renounce a voyage the fatigues of which his weak and delicate constitution could not have supported.

Having abandoned this plan, which had given him much pain and uneasiness, he applied himself with the whole activity of his soul to physical mathematics. He laboured with great diligence, and surpassed so much the hopes conceived of him by the academy, that, before the expiration of the time fixed in his agreement, he found himself honoured with the title of ordinary academician. In the short space of little more than two years, he presented and read eight memoirs, inserted in the six first volumes of the *Nova Acta Academiæ Scientiarum Imperialis Petropolitanæ*, which display great penetration, a precise and acute mind, a solid judgement, and much more address in the management of analytical formulæ than could have been expected from a geometer so young, according to appearance, in the secret of analysis and the resources of calculation.

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In 1788 his excellency Count d'Anhault appointed Mr. Bernoulli one of the profeſſors who inſtruct the Imperial corps of noble land cadets, charging him to teach algebra to the two firſt claſſes. In this office he diſtinguiſhed himſelf by much zeal and attachment to the duties it impoſed. He engaged, among other things, to make for the uſe of that corps an extract from Mr. Euler's Algebra; but death prevented him from commencing that work.

In 1789 Mr. Bernoulli married the youngeſt daughter of Mr. John Albert Euler. This marriage, which promiſed to the young couple durable felicity, and which united two names equally dear to the ſciences, and reſpectable in the republic of letters, was diſſolved, two months after it was ſolemniſed, by the tragical death of the huſband, who was carried off by a ſtroke of the apoplexy on the 3d of July the ſame year. A reſidence in the country, and the convenience of bathing every day in the Neva, had made him reſume a taſte for that practice and the exerciſe of ſwimming, which is ſo ſalutary, but ſo often fatal. He was well accuſtomed to the art, and conſequently had no fear of any unlucky accident; but whether he had neglected to dip his head firſt, or had bathed too ſoon after dinner, during the operation of digeſtion, which to him was difficult, or whether the germ of the malady had been already in his conſtitution, he ſuddenly became inſenſible and motionleſs; and though he was almoſt immediately drawn out by his brother-in-law, and though all the uſual methods were tried, aſſiſtance was uſeleſs, and the phyſicians unanimouſly declared that he had been ſtruck with a ſtroke of the apoplexy. It has been already obſerved, that Mr. Bernoulli was of a weak and delicate conſtitution. In the autumn of the year 1787 he was attacked by a nervous fever, which expoſed his life to great danger. He, however, recovered; and it is to be preſumed that his conſtitution would have been eſtabliſhed, and that it would have been able to reſiſt the ſeverity of the climate of Ruſſia, if Providence had not

poſed otherwiſe, by ſnatching him from the ſciences and the academy in the 29th year of his age.

To an open, free, and tractable diſpoſition, Mr. Bernoulli joined much modeſty and mildneſs—qualities which procured him the friendſhip and eſteem of all thoſe with whom he was acquainted, and which juſtified, as much as his learning, the deep regret occaſioned by his premature death. The following is a liſt of his writings:

Diſſertatio Inauguralis Juridica. Baſiliæ, 1778.

Theſes Juridicæ. Ibid. 1779.

Theſes de Sublimi. Ibid. 1780.

Deſcription of a Tour through Swiſſerland, in the month of Auguſt 1780. (In John Bernoulli's Collection of Short Tours, Vol. III.)

Lettre ſur l'Elaſticité. (In the Journal de Phyſique de l'Abbé Rozier, Suppl.)

Memoire ſur la Theorie d'un Inſtrument qu'on pourroit nommer Machine Baliſtique. (Mem. de l'Acad. Royale des Sciences et Belles-Lettres de Berlin, ann. 1781.)

Thoughts on the Queſtion, Why in our Diſappointments we find Conſolation in the Misfortune of Others? (*Nutz Beytrage zu den Neuen Strelitziſchen Anzeigen.* Jan. 1782.)

Theſes Phyſicæ. Baſil. 1782.

Eſſai d'une Nouvelle Maniere d'Enviſager les Differences, ou les Fluxions des Quantites Variables. (Mem. des Correſp. de l'Acad. Royale de Turin, ann. 1784 and 1785, Tom. I. p. 2.)

Obſervations made in a Tour from Vienna through Styermarck, the Ukrain and Friaul, 1785. (In John Bernoulli's Collection of Short Tours, Vol. XVI.)

Conſiderations Hydroſtatiques. (Nova Acta Helvetica, Tom. I.)

Analytical Solutions reſpecting a Parachute attached to a Balloon. (*Leipz. Magaz. fur Reine u. Angew Marthe.* Part I. 1786.)

Sur

Sur le Mouvement Gyratoire d'un Corps attaché à un Fil extenſible. Premiere Memoire. (Nova Acta Acad. Sc. Imp. Petrop. Tom. I. pro anno 1783.)

Sur le Mouvement Gyratoire, &c. *Second Memoire.* (Nova Acta, Tom. II. 1784.)

Sur le Mouvement Gyratoire, &c. Troiſieme Memoire. (Nova Acta, Tom. III. 1785.)

Dilucidationes in Commentarium III. Euleri de Ictu Glandium contra Tabulam Exploſarum. (Nova Acta, Tom. IV. 1786.)

Eſſai ſur un nouvelle Machine Hydraulique propre à élever de l'Eau. (Ibid.)

Eſſai Theorique ſur les Vibrations des Plaques élaſtiques Rectangulaires et Libres. (Nova Acta, Tom. V. 1787.)

De Motu progreſſivo, rotatorio et oſcillatorio duorum Corporum Ope Fili ſuper Trochleam tranſeuntis connexorum. (Nova Acta, Tom. VI. 1788.)

De Motu et Reactione Aquæ per Tubos mobiles transfluentis. (Ibid.)

Mr. Bernoulli tranſlated alſo Merian's Philoſophical Memoirs (*Memoires de Philoſophie de M. Merian*) into German. 2 vols.

NEW PUBLICATIONS.

Nova Acta Acad. Scient. Imper. Petropolitanæ, &c. New Tranſactions of the Imperial Academy of Sciences at Peterſburgh. Vol. X. 1797. With 13 Plates.

OF the mathematical papers in this volume, moſt of which are by Leonard Euler, it is impoſſible to give any ſatisfactory account in the limits allotted for this preſent article. Among the aſtronomical papers are:—On the Perturbation of the Motion of Saturn, by Schubert. The author has

 employed,

employed, but with ſome variation, the formula of De la Place in regard to the theory of Jupiter and Saturn. On the Variation of the Obliquity of the Ecliptic, and of the Tropical Year, by the ſame. Obſervations made in the Obſervatory of the Academic College at Mietau, from 1791 to 1795, by M. Beitler. Obſervations made in 1795 at his own houſe, by M. Inochodzow. Obſervations on a Solar Eclipſe, by M. Kumowſki. Extracts from Meteorological Obſervations made in 1768 and 1769, at Jakutſk, by J. Iſlenief. The greateſt height of the barometer was 28·07 Paris inches, the leaſt 26·17. On the 11th of December 1768, at 4 in the afternoon, the mercury of a De Liſle's thermometer, the ſcale of which reached only to 228° below boiling water*, ſunk entirely into the bulb. About 8 o'clock on the 12th, the obſerver expoſed to the open air another thermometer, the diviſions of which reached down to 245°; and at 8 o'clock in the morning of the 15th, the quickſilver ſtood at 229° (62·8° Fahr. below 0°). Having moved the inſtrument, the quickſilver fell ſuddenly into the bulb, and remained in it till 8 o'clock in the morning of the 19th; but at noon it roſe to 199° (26·8 of Fahr. below 0°). Extracts from Meteorological Obſervations made at Peterſburgh in 1792. In the department of Phyſics we find C. F. Wolff's Tenth Diſſertation, fourth part, on the Muſcular Veſſels of the Heart, illuſtrated with engravings. Method of purifying Corrupted Water, with new Experiments, by Lowitz. A little ſulphuric acid and common ſalt, when the water is intended for the purpoſes of cookery, ſtrengthens the effect of the charcoal powder. The ſame author gives an account of his having diſcovered Strontian earth in ſulphat of barytes, in which, according to his numerous experiments, it forms a fifth part, and is always preſent. He explains the difference between it and cal-

* The ſcale of De Liſle's thermomerer commences with the point of boiling water. The freezing point is 150° below boiling. EDIT.

careous

careous earth and barytes chiefly by its union with acids, and gives directions for preparing the muriat of barytes for medical purpoſes. Three papers by B. Sewergin, on different ſpecies of talc, the Ruſſian kinds of ſerpentine, and the cyanite. A Phyſical and Topographical Sketch of Tauria, by Profeſſor Pallas; alſo a Deſcription of ſome new Siberian Plants (with figures) from the Collection of the late J. Sievers of Hanover, viz. two ſpecies of robinia, the *jubata* and *tragacanthoides*; a ſpecies of ſophera, *argentea*; tamariſks, *ſongarica*; roſes, *berberifolia*; molucella, *diacanthophylla*; rhubarb, *leucorhizon*; and three kinds of ribes, *ſaxatilis*, *fragrans* and *triſtis*. Herrman's Mineralogical Obſervations made during a Journey through the Chain of the Ural Mountains, which he traverſed from Weſt to Eaſt. J. T. Kölreuter on the true Organs of Fructification in the *Periploca Græca*. Profeſſor Lepechin's Deſcription of a new Siberian kind of *Polygonum*, which he calls *Laxman*, from the diſcoverer, and of which a figure is given. It has a large ſtem, and its flowers are furniſhed with eight ſtamina and three ſtyles, placed in tender panicles at the angles of the leaves, which are lanceolated, of equal breadth, ſmooth, and ſharp pointed.

Reiſe durch Pommern nach der Inſel Rügen, &c. A Tour through Pomerania to the Iſle of Rugen and a Part of the Duchy of Mecklenburg, in the Year 1795. In a Series of Letters, by John Frederic Zöllner. With Copper Plates. Berlin 1797, 8vo.

THE route which the author purſued, in this tour, was through Stettin, Wollin, Swinemünde, Wolgaſt, Greifswald, Stralſund, Hiddenſä, Barth, Roſtock, Dobran, Remplin, Strelitz, Ruppin, and thence to Berlin. The work, beſides a deſcriptive account of the places which the author viſited, contains alſo anecdotes of remarkable perſons, and obſervations reſpecting trade, manufactures and natural hiſtory. In an Appendix is given a great many ſtatiſtic obſervations

relating to Pomerania, Rugen, Mecklenburg, &c. Tables of the exports and imports of Stettin in the year 1794; of the number (535) and value of the ſhips built in Swediſh Pomerania, between the years 1781 and 1795; and of the heights of the barometer on the 6th of Auguſt 1795, obſerved at Peterſburgh, Berlin, Halle, Breſlau, Rudolſtadt, Bayreuth, Seburg, the Brocken, St. Gothard, two eminences in Rugen, and at other places.

Voyage Pittoreſque de la Syrie, &c. Pictureſque Travels through Syria, Phenecia, Paleſtine and Lower Egypt. No. I. and II. Paris, 1798.

THIS work conſiſts of elegant engravings accompanied with proper deſcriptions. The plates in the firſt number are: 1. A view of the cenotaph of Caius Cæſar near Hems, formerly Edeſſa. 2. View of a part of the village of Cana in Galilee. 3. General view of Jeruſalem. 4 and 5. Sepulchral monument of the cities of Judah. 6. Fortune-tellers. Thoſe of the ſecond number are: 1. Gate of the Temple of the Sun at Palmyra. 2 and 3. Portico of Dioclesian. 4. Beautiful view near Tripoli. 5. Entablature of the Temple of the Sun at Balbec. 6. Courſe of the Nahr Quades or Sacred River.

The whole work will be compriſed in three volumes folio, containing about 300 engravings beſides vignettes, and will make 50 or 55 numbers. The price of each number, to ſubſcribers, is 30 livres (25 ſhillings); to non-ſubſcribers 35 livres (about 29 ſhillings).

INTEL-

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

FRANCE.

SOCIETY OF HEALTH IN THE COMMUNE OF NANCY.

THE public ſitting of this ſociety on the 1ſt of Frimaire, VII. Year, was opened by C. Lallemand, preſident, who read a diſcourſe on the utility of medical correſpondence for preſerving purity of principles in the art of healing, and on the moſt advantageous method of teaching it.

C. Mandel, profeſſor of therapeutics and pharmacy, read a diſſertation on iron. The author explained the different ſtates in which it is found naturally; thoſe which may be given to it by art; and the ſervices which it has rendered to mankind by its magnetic properties, particularly in regard to the mariner's compaſs, and its power of attracting lightning and conducting it to any place required. He demonſtrated the affinity of this metal with oxygen, the cauſe of its ſo eaſily uniting with ſaline ſubſtances, and of its ſpeedy oxydation by air and water, and of its ſolution in the latter vehicle which it decompoſes. He then proceeded to the action of iron on the animal economy, and took a view of the ſpeedy cures which it effects; and the accidents, on the other hand, which it has occaſioned to ſome individuals, even when the doſe was weak. This led him to propoſe the following very intereſting queſtion, Whether the iron which exiſts materially and formally in our humours, and above all in the blood, might not be conſidered, on account of its natural

increaſe and diminution, as the cauſe of a great number of diſeaſes? And he mentioned chloroſis as one of thoſe moſt likely to conduct to a ſatisfactory reſult.

He mentioned the new ſyſtem (quoting Dr. Rollo), which holds that the greater or leſs quantity of oxygen in the blood is the cauſe of various diſeaſes. Without denying this principle, he combated the application made of it by Dr. Rollo to certain diſeaſes, particularly chloroſis, which he imputes to a privation of oxygen; to reſtore which, he recommends metallic oxyds as being proper to furniſh oxygen. C. Mandel aſſerts that this diſeaſe is deſtroyed by medicines capable of carrying off oxygen, inſtead of introducing it into the ſyſtem: that it is cured by iron which has undergone no other preparation than a great diviſion of its parts; from which he concludes, that not diſoxygenation, but rather *deferrugination*, ought to be aſſigned as the determining cauſe.

The author next pointed out the different medical caſes in which iron, or preparations of it, ought to be adminiſtered; and then examined the queſtion whether the magnet ought to be admitted among the means of medical cure, or entirely rejected. He gave an account of the different ſyſtems of the partiſans and antagoniſts of this mineral: he combated from experience the opinion of the latter, and ſhewed that there was nothing leſs doubtful than that the iron contained in the blood, though in a ſtate of oxyd, cannot be attracted by the loadſtone. In the laſt place, he concluded, without admitting all the wonders aſcribed to it, that this mineral ought to be retained among the curative means.

C. Salmon, profeſſor of the materia medica, communicated two obſervations which tended to ſupport the laſt aſſertion.

C. Willemet, profeſſor of botany, read ſome fragments in regard to the natural and literary hiſtory of ſeveral kinds of laurel—a plant held in great veneration by the ancients. This valuable tree was employed in all their religious ceremonies,

monies, had a ſhare in their myſteries, and was made the reward of valour, merit and virtue. Its medical properties were not forgotten. In ſpeaking of the laurel-cherry, (*prunus lauro-cerafus*, L.) C. Willemet gave an account of the modern experiments made on the effects of the water diſtilled from it. He took a view alſo of the qualities and virtues of the common roſe-bay or oleander (*nerium oleander*, L.); the —— (*ruſcus hypogloſſum*, L.); and the laureſtine (*viburnum tinus*, L.)

ITALY.

The National Inſtitute of the Ligurian Republic was inſtalled on the 24th of Brumaire, 7th year, by the directory of that republic. It conſiſts of ſixty members, thirty-ſix of whom are reſident; and thirty-ſix aſſociates, inhabitants of the republic. They form two claſſes, each of which is ſubdivided into three ſections.

The firſt claſs is that of the Mathematical and Phyſical Sciences; the three ſections of which are: 1ſt, Agriculture, commerce and manufactures; 2d, The nautical ſcience, mathematics, phyſics and natural hiſtory; 3d, Chemiſtry, botany, anatomy, medicine and ſurgery.

The ſecond claſs comprehends Philoſophy, Literature, and the Fine Arts. Its ſections are as follows: 1ſt, The art of reaſoning; and analyſis of the operations of the human underſtanding, grammar, eloquence and poetry; 2d, Political ſciences, hiſtory and antiquities; 3d, The art of deſign.

ROYAL SOCIETY OF LONDON.

Since our laſt report, (Vol. II. p. 327) Papers on the following ſubjects have been read to the Society.

One on the methods of finding the latitude by double obſervations, which contained ſeveral curious calculations and uſeful tables. This paper, which occupied almoſt the whole of two evenings, is of ſuch a nature that our limits will not allow our giving any account of it.

A paper containing meteorological obſervations made at Conſtantinople, and ſome curious information reſpecting the plague which ſo often cauſes dreadful devaſtation in the Eaſtern countries. The remarks brought forward on this ſubject go to eſtabliſh the fact, that the infection is only caught by contact either of a diſeaſed perſon, or of articles that have been in contact with the infected.

A paper on the natural hiſtory of the elephant, by John Corſe, Eſq. author of the article on the ſame ſubject given in a preceding part of the preſent number of our work. This paper, which contains a great variety of curious information, excited much attention. His obſervations are the reſult of many years reſidence in India. By them it appears that the accounts of the ſagacity, modeſty and ſize of the elephant have been greatly exaggerated by natural hiſtorians. The female, when brought forth, is about 35 inches high; when full grown, from 7 to 8 feet. A full grown male is 8 or 9 feet high, meaſured at the ſhoulder as the height of a horſe is taken.

A paper on the decompoſition of the boracic acid, by M. Crell.

ANTIQUARIAN SOCIETY OF LONDON.

On Thurſday the 14th of Feburary, an Eolopile of great antiquity, made of braſs, and which had been dug up in making the Baſingſtock canal, was preſented to this Society by Mr. Fry the letter-founder. The form is ſingular: inſtead of being globular with a bent tube, it is in the form of a groteſque human figure. The blaſt comes from its mouth. The only thing ſimilar we have ever met with in this country is the eolopile called Jack of Hilton, mentioned in Plott's Hiſtory of Staffordſhire.

MISCELLANEOUS.

ANTIQUITIES.

MEN of letters, artiſts, and thoſe fond of antiquities and numiſmatics, had long regretted, that the rich collections of medals and gems in poſſeſſion of the royal family of Pruſſia were ſcattered and preſerved in different places. The late king, who approved of a plan preſented to him for uniting all theſe collections in the capital, cauſed to be brought thither, towards the cloſe of his reign, and depoſited in his own cabinet, the beautiful collection of ancient and modern medals, crown-pieces, &c. which the margraves had formed at Anſpach, and to which he made conſiderable additions. To complete the execution of the above plan, it however ſtill remained to add to the cabinet of Berlin the grand collection of ancient medals and gems preſerved at Potſdam. This valuable collection, made by Frederick I. and deſcribed by that celebrated antiquarian Beger *, was enriched afterwards by Frederick II. who purchaſed the antique medals of Pfau, and the magnificent cabinet of gems of Baron de Hoſch, almoſt unique of its kind. This collection was brought to the capital in 1770, and placed by Frederick II. in the Temple of Antiques at *Sans Souci*, where it long ſerved for the noble amuſement of that great man, who was fond of being ſurrounded by maſter-pieces of every art, and by every ſource of inſtruction. His preſent majeſty has lately gratified the wiſhes of artiſts and men of letters, by ordering, on a propoſal made to him by the Directory of the Royal Academy

* Laurence Beger, the ſon of a tanner at Heidelberg, and born in 1653, was librarian to Frederic William, elector of Brandenburgh. He was member of the Academy of Berlin, and died there in 1705. He was eſteemed by the Learned for his works, among which are: Theſaurus ſive Gemmæ, Numiſmata, &c. 3 vol. fol. 1696 and 1701; Regum et Imperatorum Numiſmata à Rubenio edita 1700, fol.; De Nummis Cretenſium Serpentiferis, 1702. fol. EDIT.

of

of Sciences, that this collection ſhould be transferred to Berlin, and incorporated with his collection. The directory of the academy, in order to promote farther his majeſty's views, and to complete the royal cabinet, have added to it two valuable collections belonging to the academy, viz. that of Lippert's * caſts, and that of the bracteals, or coin of the middle ages, formed by Rau, and augmented by Mohſen †; ſo that the royal cabinet contains at preſent about 5400 engraved gems, 3000 caſts by Lippert, 16000 antique medals, 5000 bracteals, with 5 or 6000 modern medals and crowns. Among the modern ſeries, the richeſt is that of the medals and crowns of Pruſſia.

ANATOMY.

C. Cuvier, in the courſe of his reſearches reſpecting the anatomy of white-blooded animals, which he intends ſoon to publiſh, has found that the leech will oblige him to change the general denomination. He obſerved in that animal red blood, not that which it ſucks, and which would be contained in the inteſtinal canal, where it is immediately altered, but a real nouriſhing fluid contained in the veſſels, and circulating there by means of an alternate movement of the ſyſtole and the diaſtole. Theſe veſſels form four principal trunks, two of which are lateral, the third dorſal, and the laſt ventral. The two former are of an order different from that of the two latter; but the author has not yet been able to determine which are the arterial and which the

* Philip Daniel Lippert, profeſſor of antiquities in the Academy of the Fine Arts at Dreſden. He was born at Meiſſen in 1702, and died on the 28th of March 1785. Among his works are Dactyliotheca, or, A Collection of the Engraved Stones of the Ancients, conſiſting of 200 impreſſions from the principal cabinets in Europe, for the uſe of the fine arts and artiſts. Leipſic, 1767. A Supplement to the Dactyliotheca, conſiſting of 1049 impreſſions. *Ibid.* EDIT.

† John Charles William Mohſen, member of the college of phyſicians, phyſician to his Pruſſian Majeſty, and to the ſchool of Noble Cadets at Berlin. EDIT.

venal.

venal. The two lateral veſſels proceed from one end of the body to the other, and are joined by branches which form a very beautiful tiſſue when injected. The ventral and dorſal veſſels do not form a tiſſue of the like kind. They only throw out branches diſpoſed alternately in an oblique direction, and ſubdivided in the uſual manner. The ſecond is placed exactly under the medullary cord of the ganglions, from which all the nerves proceed. It is impoſſible to open a leech without producing a great effuſion of that blood. Enough, however, remains in the veſſels to be diſtinguiſhed. Its colour is almoſt the ſame as that of the arterial blood of the frog.

NORTHERN GEOGRAPHY AND STATISTICS.

M. Hammer, conductor general of the dioceſe of Aggerhuus in Norway, who left all his property to the Royal Norwegian Academy of Sciences, endowed alſo a foundation, which has been confirmed by his Daniſh Majeſty, and in conſequence of which a part of the money bequeathed is to be laid out in printing his manuſcripts, and for purchaſing natural curioſities, the productions of Norway. Another part is to be employed in defraying the expence of travels through Norway, and the following diſtricts are in particular to be explored: Neiden, Powig, Peiſen, Nordfieldet, the White Sea, and Dvinaan, the moſt remarkable natural objects of which muſt be deſcribed. Theſe travels are to be conducted on the plan propoſed by Linnæus in the *Norwegian Houſehold Calendar*. All remarkable objects and antiquities are to be illuſtrated with maps and drawings, and the journals of the different travellers will be inſerted among the papers of the ſociety.

Baron Hermelin, counſellor of mines, one of the richeſt men in Sweden, is now employed in preparing maps of every province of that kingdom, which he means to publiſh at his own expence. He has already begun with Lapland and the northern diſtricts.

ASTRONOMY.

On the evening of Frimaire 16th, C. Bouvard, aſtronomer belonging to the Obſervatory at Paris, diſcovered a comet in the conſtellation of Hercules. At half after ſix next morning, its right aſcenſion was 248½ degrees, and its northern declination 31½. It had advanced 43 minutes per hour towards the eaſt, and 28 towards the ſouth. It was ſmall and difficult to be ſeen. It forms the 89th, according to the catalogue, in De Lalande's Aſtronomy.

MANUFACTURES.

Michael Szekely, overſeer of mines to Count Schönborn at St. Nicholas, near Munkats in Hungary, has manufactured a kind of cloth from the ſwallow-wort (*aſclepias vincetoxicum*) interwoven with ſilk. A ſpecimen of this new production, conſiſting of 6½ German ells, was preſented to the magiſtrates of Ofven for inſpection. The firſt manufacturing of it coſt about 7 or 8 ſhillings ſterling, but in future the ſame quantity will coſt only 3 or 4 ſhillings. It was two ells in breadth, and of conſiderable fineneſs.

ARTIFICIAL COLD.

Nearly at the ſame time that Meſſrs. Pepys and Allen were engaged in the intereſting experiments, of which we have given an account in the preceding pages, Mr. Walker of Oxford was alſo employed in producing frigorific mixtures. For this purpoſe, he uſed the ſame materials in the following proportions: 4 parts of the cryſtalliſed muriat of lime, pulveriſed, to 3 parts of uncompreſſed dry ſnow. On the 4th inſtant, having, by means of a previous mixture, reduced his materials to 40 below 0°, on mixing the cooled ingredients, they gave a temperature of − 63° or 95° below the freezing point of water. We believe the experiment was only on a ſmall ſcale. We have not learnt what ſubſtances, or whether any, were expoſed by Mr. Walker to the cold mixture.

MINERALOGY.

A lode * of ſilver, tolerably rich, has lately been diſcovered in the Hurland Mine, formerly called the Old Manor Mine, in Gwinear pariſh in the county of Cornwall, which they are now working, and which, judging from preſent appearances, we ſhould expect would turn out of great national benefit, if we were not aware of the ſtrong prejudices and great ignorance of the Corniſh miners in general.

If we may credit the teſtimony of foreigners, the pooreſt mine in Cornwall is worked at a greater expence than the richeſt on the Continent. How can it be otherwiſe, while the preſent ſyſtem, diſgraceful to the age in which we live, is allowed to continue, without any attempts being made either to alter or improve it? We ſhall hardly be credited when we ſtate that, in many places, the proprietors are never permitted to have a ſection of their mine: yet ſuch is literally the fact. It would be incroaching upon the province of the *Captain of the Mine!* who is ſole monarch of the ſubterranean legions, and guides all their operations.

From this man the owners muſt be content to receive the only accounts they can obtain of the ſtate of their works; nor can they poſſibly help themſelves, or interfere in the direction.

When it is known that this is the ſtate of management, our readers, though they may regret the circumſtance, will not be ſurpriſed to hear that the Wherry-mine near Penzance, one of the moſt curious in the world †, and in which we lately announced that cobalt had been found, has been diſcontinued working, and the ſhaft been cloſed up. Have we not reaſon to fear that this mine, ſo rich in tin and cobalt, has fallen a diſgraceful ſacrifice to the ignorance in the art of mining, which ſo ſhamefully prevails in this county? While ſcience is excluded, what can be expected?

* The Corniſh term for a vein or ſtratum.

† The mouth of the ſhaft was more than 600 feet from the ſhore, and ſurrounded by the ſea.

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The French Government have lately taken the ſtate of the mines in France into their conſideration, eſtabliſhed a ſchool of mineralogy under the auſpices of the miniſter of the interior, and are now deviſing means for propagating inſtruction relative to that important branch of induſtry.—The ſtate of the mines in this country calls loudly on our Government to endeavour to deviſe ſome mean of improvement. The loſs that reſults to the community from the prevailing ignorance of the operative people employed in them is abſolutely incalculable. How happy ſhould we feel, if our well-meant hint ſhould have the effect to make the matter be taken up by thoſe who have influence ſufficient to accompliſh the object!

DEATH.

On the 26th of November laſt, of a nervous fever, Frederick Albrecht Charles Gren, Public Profeſſor of Medicine, and Member of the Society of the Searchers into Nature at Halle. He was born on the 1ſt of May 1760, at Bernburg. His premature death is a great loſs to Chemiſtry and Natural Philoſophy. The *Journal der Phyſik*, or Journal of Natural Philoſophy, begun in 1770, of which he was editor, is well known. Among his works are: Obſervations on Fermentation and the Products thence obtained, 8vo. Syſtematic Manual of Chemiſtry, 2 vols. 8vo. Principles of Natural Knowledge, 8vo. *Obſervationes et Experimenta circa Geneſin Aëris fixi et phlogiſticati*, 8vo. Principles of Pharmacology and the Materia Medica, 2 parts.—He was a contributor alſo to the *Allgemein-Literatur-Zeitung* of Jena, and author of various papers in Crell's Chemical Annals.

THE

PHILOSOPHICAL MAGAZINE.

MARCH 1799.

I. *Account of a remarkable Fiery Eruption from the Earth, in Iceland, in the Year* 1783. *By* S. M. HOLM, S.S. Theol. Cand.

THE following account is taken from a ſmall work written by Mr. Holm, a clergyman, and publiſhed in the Daniſh language at Copenhagen, with two charts. The author ſays, in his preface, that he was born in the iſland in the year 1750, and lived there till the year 1774; that he had himſelf ſeen all the places mentioned in it, and had ſince kept up an uninterrupted epiſtolary correſpondence with his countrymen, from whom he received the particulars of the devaſtation occaſioned by this ſingular diſaſter.

On the 1ſt of June 1783, ſeveral violent ſhocks of an earthquake were felt in various parts of Iceland; and theſe ſhocks afterwards increaſed to ſuch a degree, that, on the 11th of the ſame month, the inhabitants were obliged to deſert their habitations and to live in the open air. About the ſame time ſmoke and vapour were ſeen to riſe alternately from the earth in the wild diſtricts towards the north, in the neighbourhood of Sidu, Landbrot, Medalland and

Alptaver. After this three columns of fire were obſerved, the moſt northern of which firſt made its appearance. When firſt ſeen, they flamed up ſeparately; but they afterwards united and roſe to ſuch a height that they could be perceived at the diſtance of thirty-four miles, when the flame was not covered by thick vapour.

Iceland is bordered by a long chain of mountains, which are all exceedingly high and always covered with ſnow. The largeſt and higheſt of theſe is the Klofa-Jœkul, in which the principal and beſt known rivers of the iſland formerly had their ſources. Among theſe mountains there are alſo four volcanoes, the Skaptar-Jœkul, the Sula, Trœlladyngia, and the Oerœfa-Jœkul, the laſt of which is the moſt violent. They at firſt throw out water, and then fire. There are ſeveral of the ſame kind in the iſland; but the well known Hecla throws out only fire.

On the 8th of June the bright flames of the beforementioned column could be clearly diſtinguiſhed. They were accompanied with a violent and inceſſant eruption of ſand, ſulphureous duſt, aſhes, large pumice ſtones, and moſt dreadful exploſions. A furious wind, which prevailed at the ſame time, filled the atmoſphere in ſuch a manner with ſand and ſulphureous vapour, that people could not ſee either to read or to write even at noon. The aſhes and ſcoriæ which fell back from the atmoſphere were red hot. There fell at the ſame time a kind of filth as black as ink, which ſeemed as it were hairy, having ſometimes the appearance of ſmall balls, and ſometimes of wreaths or rings.

On the 11th the fiery column, which had vaniſhed for a little, again made its appearance, and could be diſtinctly ſeen at the diſtance of thirty or forty miles. Its thundering noiſe could be heard at the ſame diſtance, and continued throughout the whole ſummer. The above column was accompanied the ſame day by a very violent rain, which occaſioned infinite damage; becauſe the water, in many places, ſwept off whole pieces of the ſoil and carried them with it into

into the deep gulphs. The water of this rain was at the ſame time ſo ſharp and acrid, on account of the many ſaline and ſulphureous particles which it contained, that it occaſioned ſevere pain in the hands and feet where it fell.

The places in the neighbourhood of this column were at the ſame time expoſed to violent cold, ſnow, and hail of an uncommon magnitude; but, as the column extended farther, theſe were ſucceeded by a ſcorching and almoſt unſufferable heat, and the ſun appeared like a red globe. This heat continued for ſeveral days without interruption, and returned ſeveral times in ſucceſſion. All thoſe places to which this deſtructive column extended were, by the ſhowers of ſtones and aſhes that accompanied it, deprived of all their graſs and every other plant; ſo that the inhabitants were reduced to great diſtreſs, and their cattle were frequently killed on the ſpot. In many places every vegetable production was as it were covered by a hard cruſt, from the continual ſulphureous evaporation.

When this fiery eruption firſt broke out, the river Skapta was ſwelled up in an uncommon manner, and a like overflowing was obſerved in ſeveral other rivers. On the 11th of June the Skapta ſuddenly diſappeared, and became totally dry in the courſe of twenty-four hours. Its bed was ſituated in a gulley called Skaptar-Gliufur, which extends four miles northwards through the higheſt rocks, and is above 200 fathoms deep. In this monſtrous gulley there aroſe, the ſecond day after the Skapta was dried up, a dreadful and undeſcribable fiery lake, which gradually increaſed till it overflowed the banks and filled all the neighbouring places whether high or low, the moſt exalted ſummits only excepted. Having inundated the farm of Buland, it covered not only the adjacent fields and hedges, but alſo the houſes and the church, though the farm is ſituated on a high rock. Towards the eaſt it extended ſix miles in breadth; its extent towards the weſt was alſo conſiderable; but towards

the ſouth its progreſs had been checked by lofty mountains.

Thus ſwelled and towering up into huge waves it endeavoured on all ſides to procure a paſſage, which, by its continually preſſing forwards, it at length effected towards the ſouth in a valley between the mountains. Through this opening it ruſhed with incredible violence and force, like the moſt terrible cataract, into the plain on the ſouth, over which it rolled, amidſt ſtrong concuſſions of the earth and awful thunder and exploſions in the atmoſphere, carrying before it ſtones, rocks and ſmall eminences. This flaming lake boiled and foamed in a dreadful manner with melted ſtones, iron, and other ſubſtances capable of being liquefied; ſome of the ignited rocks and ſtones, as large as whales and houſes, were ſeen ſwimming on its ſurface, or driving up and down.

In the mean time ſmoke and vapour aroſe from the earth, both in the neighbourhood of this fiery lake and in the more remote diſtricts. All theſe appearances continued inceſſantly both day and night from the 12th of June till the 12th of Auguſt. The lake ſtill ſpread itſelf in the open plains, but with leſs impetuoſity than before. The boiling and foaming, however, continued until it at length began to ſettle, and to form itſelf into a ſolid body. In many places it was found to have been 70, and in others 140 fathoms in depth. When it threw itſelf with violence into the bed of any river, the water which it diſplaced overflowed all the adjacent lands, and ſtill added to the devaſtation and diſtreſs it occaſioned. Seventeen farms were burnt by the fiery ſtream, and four ſwept entirely away by the water, beſides a great many others which were deſtroyed by lightning and the large ſtones that fell from the atmoſphere; ſo that their inhabitants were reduced to poverty, and obliged to wander about begging for relief. Three large rivers, the before-mentioned Skapta, the Hlverfisfliot, and the Steinſmyrarfliot,

myrarfliot, beſides eight ſmaller ones, were found entirely dried up.

On the 16th of Auguſt the fiery lake began to ceaſe ſpreading farther. Wherever it proceeded it had burnt and deſtroyed houſes, churches, villages, fields, meadows and foreſts. Among the places deſtroyed were many abounding with excellent herbs, ſuch as the *elymus arenarius*, and medicinal plants; the want of which was a great and irreparable loſs to the iſland.

This fiery eruption, however, did not yet ceaſe, but continued to rage with fury till October in the middle parts of the iſland, where vapour, flames, thunder and concuſſions of the earth were in ſucceſſion obſerved among the cold and extenſive mountains. In the firſt half of November little change had taken place; but the flames began gradually to burn up with more brightneſs, which was conſidered as a ſign that the inflammable matter was now nearly exhauſted, and that the flame would be extinguiſhed; eſpecially as it had before aſſumed a variety of colours, ſuch as green, blue and the like, according to the difference of the ſubſtances by which it had been nouriſhed.

When the eruption firſt took place, the whole atmoſphere of the iſland was ſo filled with ſmoke, vapour and duſt, that the ſun had entirely a red appearance. In the neighbourhood of the mountains it was perfectly dark at noon; and the cold in the night time, conſidering the warmth of the ſeaſon, was very ſenſible. Where the atmoſphere was dry, the fire made the air highly oppreſſive; but where moiſt, ſuch ſevere winter cold was produced in it, that the graſs, plants, and cattle were almoſt deſtroyed. The cows gave ſcarcely an eighth part of the uſual quantity of milk; and a four-year-old wether, which before would have had ten pounds of fat, had now only two, and was ſo weak as to be ſcarcely able to ſtand.

The aſhes, ſulphur and rain which fell from the heavens, were ſo peſtilential that they ſeemed to penetrate the very

bodies of the cattle. Their hoofs became white; their hair fell off; and they were covered all over with puſtules and ulcers. The meadows alſo ſuffered ſeverely; and the cattle which had endeavoured to pick up the few ſcanty remains of graſs that had been left, might be ſeen lying dead on them in heaps. Many others were deſtroyed by hunger; and it was only a few that were ſaved by the means of hay. The cattle in general were ſo ſtunned, ſometimes by the dreadful exploſions of the thunder, and the inceſſant roaring and fire in the atmoſphere, that they ran into marſhy places, threw themſelves over precipices, or even ruſhed into the flames.

Theſe uncommon phenomena were no leſs deſtructive to the inhabitants. Many, in particular old people, and thoſe whoſe lungs were weak, could with difficulty breathe on account of the ſulphureous ſtench and vapour proceeding from the flames. Many alſo who enjoyed good health were reduced to a ſtate of illneſs; and many would have been ſuffocated had not moderate ſhowers of rain, which fell ſometimes, cooled and refreſhed the atmoſphere.

Beſides theſe circumſtances which took place in Iceland, many other phenomena worthy of notice occurred in the neighbourhood. A new iſland was thrown up in a part of the ſea where, according to the account of experienced ſeamen, the water before had been about a hundred fathoms in depth. Its diſtance from Iceland was ſixteen, and from Bird Iſland eight miles. In the month of Auguſt it threw up bright flames; and it continued to burn till February 1784. Later accounts ſtate that towards the end of the year it threw up a large column of fire intermixed with ſand. This iſland was about half a mile in circumference, and its height appeared to be equal to that of the mountain Eſian.

Towards the north-weſt, nearer to Iceland than the old eaſtern gulph of Greenland, lies another very high iſland, larger than the former; which, according to the lateſt ac-

counts, has for a long time burnt day and night. We have been informed alſo by accounts from Iceland and Norway, that a violent fiery eruption took place in the moſt diſtant wilds of Greenland, oppoſite to the northern part of Iceland; and alſo in other places, previous to that of the latter above deſcribed. This is confirmed by letters dated September the 14th, in which it is ſaid that a violent north wind from the ſea had brought over to the northern coaſt of Iceland abundance of aſhes, with a ſtrong ſulphureous ſmell; and this phenomenon continued the whole ſummer.

The effects of theſe remarkable phenomena ſeem to have extended alſo to other countries. At the time when the before mentioned acrid rain prevailed in Iceland, an uncommonly ſharp and penetrating rain of the like kind fell at Drontheim and other parts of Norway. In the Feroe iſlands this rain burnt as it were the leaves of the trees, and the graſs on the fields had a blackiſh appearance. When the wind blew from the N.W. great quantities of aſhes, ſand and ſulphureous vapour fell in theſe iſlands, though they are eighty miles diſtant from Iceland; and the ſails and decks of ſeveral ſhips, while on their paſſage between Copenhagen and Iceland, were covered with black ſandy duſt. Even in Zealand and at Copenhagen the ſun, from the beginning of June till the 8th of Auguſt, ſeemed remarkably red; and throughout the whole month of July the atmoſphere was ſo filled with duſt and vapour, that the ſun could not be ſeen in the evening after eight or nine o'clock. Even at noon the ſun was red, and this was obſerved in the night-time to be the caſe with the moon and the ſtars. The learned Profeſſor Kratzenſtein ſaid that theſe phenomena muſt proceed from a fiery eruption in Iceland; which was the more remarkable as Iceland lies at the diſtance of almoſt 300 miles from Copenhagen, towards the north-weſt. Others ſaid they aroſe from the great heats which frequently happened, and particularly on the 27th and 29th of July, and the 5th of Auguſt. The earth

at this time was almoſt incapable of producing either herbs or graſs, and the leaves even withered on the trees. A whitiſh grey kind of duſt was ſeen to fall towards the ground; and the fields in the night were often overſpread with a blueiſh miſt, which was accompanied with a certain pale fiery brightneſs and a ſulphureous ſmell. During the nights when this fog prevailed, little or no dew fell. Phenomena of the ſame kind were obſerved in Germany, Holland, and other countries.

II. *An Account of* TOALDO's *Syſtem reſpecting the Probability of a Change of Weather at the different Changes of the Moon. From* Journal des Sciences Utiles.

WERE the ſun the only cauſe of the variations of the weather, the regular courſe of that luminary, from year to year, would produce the ſame weather in the ſame ſeaſons. The principal variations of the weather, however, depend upon ſome other cauſe not ſo uniform, the diſcovery of which has long given employment to philoſophers; and as we find that the motion of the ſea ſeems to have an intimate connection with the motion of the moon, it has thence been believed, that the latter acts a principal part, not only in this phenomenon of the flux and reflux, but that it could not produce theſe variations on the earth, without having, at the ſame time, a conſiderable influence on the atmoſphere. The difference of the fluids which compoſe it, and, above all, the great elaſticity of the air, can alter this effect, but not entirely deſtroy it.

It is well known that no philoſopher has yet been able, from mere theory, to form any proper concluſion reſpecting theſe variations of the weather. To ſupply this deficiency, M. Toaldo called in the aid of experience, and compared the ſtate of the atmoſphere with the ſituation of the moon, where its activity appeared to be ſtrongeſt and weakeſt.

From

From obſervations made at Padua on this ſubject, during the courſe of fifty years, he at length found that good and bad weather have been always determined by certain ſituations of the moon; and this circumſtance furniſhed him the means of foretelling, with ſome degree of certainty, the ſtate of the atmoſphere by the ſituation of that luminary deduced from aſtronomical calculations. He diſtinguiſhes ten ſituations of the moon, each of which is capable of producing a ſenſible effect on our atmoſphere; and, in order to comprehend theſe, it muſt be obſerved, that the motion of the moon has three different relations, from which there ariſe the ſame number of revolutions, and that each of theſe has a particular duration, and at the ſame time certain ſituations, as expreſſed in the following table:

REVOLUTIONS.	SITUATIONS OF THE MOON.
1. *Synodical*, in regard to the ſun; continues 29 days 12 hours 44 minutes.	New moon Firſt quarter Full moon Laſt quarter
2. *Anomaliſtic*, in regard to the moon's courſe; continues 27 days 13 hours 43 minutes.	Apogeum Perigeum
3. *Periodical*, in regard to the moon's paſſing the equator; continues 27 days 7 hours 43 minutes.	Aſcending equinoxes * Northern luniſtices † Deſcending equinoxes Southern luniſtices

* The two paſſages of the moon over the equator are called by M. Toaldo, one the *aſcending*, and the other the *deſcending equinox*. EDIT.

† The two *luniſtices*, as M. de la Lande has called them, are: 1ſt, the *boreal luniſtice*, when the moon approaches as near as ſhe can in each lunation to our zenith: 2d, the *auſtral luniſtice*, when ſhe is at the greateſt diſtance from it. EDIT.

The

The ſituations of the moon which have a relation to the ſynodical revolution, are well known. It may, however, be remarked, that new and full moon are called the ſyzigies, and the firſt and laſt quarter the quadratures. The perigeum and apogeum are comprehended under the term apſides.

On account of the difference in the periods of theſe three revolutions, the ſituations of the moon do not return in the ſame order, till after a long ſeries of years; and in the difference of their coincidence, connected with the regular effect of the ſun at each ſeaſon, lies the cauſe of the different variations of the weather. The following are the rules which M. Toaldo has deduced from his obſervations.

The probabilities that the weather will change at a certain period of the moon are in the following proportions:

New moon	6 : 1
Firſt quarter	5 : 2
Full moon	5 : 2
Laſt quarter	5 : 4
Perigeum	7 : 1
Apogeum	4 : 1
Aſcending equinox	13 : 4
Northern luniſtice	11 : 4
Deſcending equinox	11 : 4
Southern luniſtice	3 : 1

That is to ſay, a perſon may bet ſix to one, that the new moon will bring with it a change of weather. Each ſituation of the moon alters that ſtate of the atmoſphere which has been occaſioned by the preceding one; and it ſeldom happens that any change in the weather takes place without a change in the lunar ſituations. Theſe ſituations are combined, on account of the inequality of their revolutions, and the greateſt effect is produced by the union of the ſyzigies with the apſides. The proportions of their power to produce variations are as follows:

New

New moon coinciding with the perigeum	-	33 : 1
Ditto . . . . . with the apogeum	-	7 : 1
Full moon . . . with the perigeum	-	10 : 1
Ditto . . . . . with the apogeum	-	8 : 1

The combination of theſe ſituations generally occaſions ſtorms and tempeſts; and this perturbing power will always have the greater effect, the nearer theſe combined ſituations are to the moon's paſſage over the equator, particularly in the months of March and September. At the new and full moons, in the months of March and September, and even at the ſolſtices, eſpecially the winter ſolſtice, the atmoſphere aſſumes a certain character, by which it is diſtinguiſhed for three, and, ſometimes, ſix months. The new moons which produce no change in the weather, are thoſe that happen at a diſtance from the apſides.

As it is perfectly true that each ſituation of the moon alters that ſtate of the atmoſphere which has been produced by another, it is however obſerved that many ſituations of the moon are favourable to good and others to bad weather. Thoſe belonging to the latter claſs are: the perigeum, new and full moon, paſſage of the equator, and the northern luniſtice. Thoſe belonging to the former are: the apogeum, quadratures, and the ſouthern luniſtice. Changes of the weather ſeldom take place on the very days of the moon's ſituations, but either precede or follow them. It has been found by obſervation, that the changes effected by the lunar ſituations in the ſix winter months precede, and in the ſix ſummer months follow them.

Beſides the lunar ſituations to which the above obſervations refer, attention muſt be paid alſo to the fourth day before new and full moon, which are called the octants. At theſe times the weather is inclined to changes; and it may be eaſily ſeen, that theſe will follow at the next lunar ſituation. Virgil calls this fourth day a very ſure prophet. If on that day the horns of the moon are clear and well defined,

good

good weather may be expected; but if they are dull, and not clearly marked on the edges, it is a ſign that bad weather will enſue. When the weather remains unchanged on the fourth, fifth and ſixth day of the moon, we may conjecture that it will continue ſo till full moon, even ſometimes till the next new moon; and in that caſe the lunar ſituations have only a very weak effect. Many obſervers of nature have alſo remarked, that the approach of the lunar ſituations is ſomewhat critical for the ſick.

Conjectures on the Periods of Rain.

The riſing and ſetting of the moon, as well as its ſuperior and inferior paſſage of the meridian, may ſerve as a rule for foretelling the times of rain. M. Toaldo calls theſe ſituations the moon's angles.

The times moſt expoſed to rain are the riſing and ſetting; thoſe moſt favourable to good weather, the paſſage of the meridian. It has been remarked that, during rainy days, bad weather is always a little interrupted about the time when the moon paſſes the meridian. We muſt, however, make an exception to this rule as often as the angle of the moon does not coincide with that of the ſun. As theſe obſervations may be very eaſily made, by means of aſtronomical tables, in which the angles of the moon and ſun are marked, they are exceedingly well calculated to prove the truth of this ſyſtem. No one, for inſtance, will refuſe aſſent to it, when the daily changes correſpond with the angles of the moon; and when, independently of the effects of the moon's ſituation, the horizontal effect of the moon at riſing and ſetting is different from that produced by its paſſage over the meridian.

It rains oftener in the day time than in the night, and oftener in the evening than in the morning.

Influence of the Moon in regard to extraordinary Years.

Bad years take place when the apſides of the moon fall in the

the four cardinal points of the zodiac. Their intervals, therefore, are as 4 to 5, 8 to 9, &c. or as the intervals of the paſſage of the apſides through the four cardinal points of the zodiac. Thus the year 1777 was, in general, a bad year; and in that year the apſides of the moon were in the equinoctial ſigns; and it is probable that the years in which the apſides fall in the ſigns Taurus, Leo, Virgo and Aquarius, will be good and moderate years, as the year 1776 really was; and in that year the apſides of the moon were in Taurus and Virgo.

Every eighteenth year muſt be ſimilar. We, however, can not depend upon a return altogether the ſame, on account of the three different revolutions of the moon; and therefore it may happen, that the epoch of this extraordinary year may be retarded a year or perhaps two. Though approximations only are here given, this does not prevent their being uſeful to farmers, if they only pay attention to circumſtances. Beſides, various exceptions muſt be made for different parts of the earth; and it is difficult to determine theſe beforehand, as what regards this ſyſtem is applicable to the whole globe; but when the reſult of the ſyſtem has been improved by local obſervations, the conjectures for each country will be attended with more certainty.

The fifty-fourth year muſt have a greater ſimilarity to the firſt than to all the reſt; becauſe, at this period, the ſituations of the moon, in regard to the ſun and the earth, are again found in the ſame points.

The quantity of the rain which falls in nine ſucceſſive years is almoſt equal to that which falls in the next following nine. But this is not the caſe when we compare in like manner the quantity of rain which falls in ſix, eight or ten years.

Effects of the Moon on the Barometer.

The variations of the barometer are ſo intimately connected with changes of the weather, that there is reaſon to ſuppoſe that the moon has ſome influence on the ſtate of that inſtru-

ment,

ment. For the ſake of more certainty, however, M. Toaldo compared a diary of the ſtate of the barometer, kept for many years, with the ſituations of the moon, and found the following reſult: 1ſt, That the barometer at the time of the moon's apogeum riſes the ſixth part of a line higher than at the perigeum; 2d, that at the time of the quadratures it ſtands a tenth of a line higher than at the time of the ſyzigies; and 3d, that it is a fourth of a line higher at the ſouthern luniſtice than the northern.

Thus far the compariſon of the moon's ſituations with the ſtate of the barometer agrees perfectly with meteorological obſervations. This, however, is not the caſe at the time of the moon's paſſage through her equinoctial points; for the heights of the barometer are then greater, chiefly when ſhe paſſes in Libra: a circumſtance which is contrary to meteorological obſervations, ſince theſe ſituations of the moon indicate bad weather. It muſt, however, be remarked, that in this contradiction the indications of the moon's ſituations are more to be depended on than thoſe of the barometer.

It has a like connection with the coincidence of the equinoctial point and the perigeum, which alſo gives heights conſiderably greater. The union of theſe points, however, is a ſign of great irregularity. It muſt here be remarked that, according to De Luc, the rapid movement of the barometer indicates a ſtorm of ſhort duration, and that in ſuch a caſe, even when it riſes, bad weather is likely to follow.

M. Toaldo ſays, that the Europeans, when they firſt viſited Mexico, found a ſingular cuſtom prevalent in that country. When a new emperor was choſen, he was obliged to ſwear that, during his government, rain ſhould fall according to the pleaſure of his ſubjects; that no inundations ſhould be occaſioned, and that the fields ſhould not be rendered unfruitful, &c. The multitude imagine that the meteorologiſt enters into an obligation of the like kind; but all that can be expected from him is confined merely to conjectural rules reſpecting changes of the weather; and even theſe

prognoſtics,

prognoſtics, when determined for particular places, muſt not be conſidered as free from frequent error, as thoſe cauſes which act upon the earth, in general, may be much changed by local cauſes in different diſtricts.

III. *On the preſent State of Surgery in Turkey. From* A Survey of the Turkiſh Empire. *By* W. Eton, *Eſq.*

IT might reaſonably be expected that a nation of warriors ſhould have expert ſurgeons at leaſt, and that they ſhould have paid attention to the improvements and diſcoveries made by other nations. Nothing of this, however, is the caſe. They perform no operations, nor will they conſent to an European's making an amputation, though the loſs of life be a certain conſequence of omitting it. Their art is ſimply confined to healing, and at moſt extracting a ball and a ſplinter of a bone. It muſt be confeſſed that, as their habit of body is generally healthy, nature performs often wonderful cures. They rely much on balſams, mummy, &c. There is in Conſtantinople a Perſian extraordinary expert in the art of healing. The Arabs bury a perſon, who has received a wound in his body, up to the neck in hot ſand for twenty-four hours; and apply with ſucceſs the actual cautery for the dropſy.

I ſaw in the eaſtern parts of the empire a method of ſetting bones practiſed, which appears to me worthy of the attention of ſurgeons in Europe. It is by incloſing the broken limb, after the bones are put in their places, in a caſe of plaſter of Paris (or gypſum) which takes exactly the form of the limb, without any preſſure, and in a few minutes the maſs is ſolid and ſtrong. If it be a compound fracture, the place where the wound is, and out of which an exfoliated bone is to come, may be left uncovered, without any injury to the ſtrength of the plaſter encaſement. This ſubſtance may be eaſily cut with a knife, and removed, and replaced with

with another. If, when the ſwelling ſubſides, the cavity is too large for the limb, a hole or holes being left, liquid gypſum plaſter may be poured in, which will perfectly fill up the void, and exactly fit the limb. A hole may be made at firſt by placing an oiled cork or bit of wood againſt any part where it is required; and when the plaſter is ſet, it is to be removed. There is nothing in gypſum injurious, if it be free from lime; it will ſoon become very dry and light, and the limb may be bathed with ſpirits, which will penetrate through the covering. Spirits may be uſed inſtead of water, or mixed with it (or vinegar) at the firſt making of the plaſter.

I ſaw a caſe of a moſt terrible compound fracture of the leg and thigh, by the fall of a cannon, cured in this manner. The perſon was ſeated on the ground, and the plaſter caſe extended from below his heel to the upper part of his thigh, whence a bandage, faſtened into the plaſter, went round his body. He reclined back when he ſlept, as he could not lie down. During the cure, where they ſaw matter or moiſture appear through the plaſter coating, they cut a hole with a knife to dreſs the wound, or let out the matter more freely.

On this occaſion I cannot help mentioning the treatment of parts frozen in Ruſſia, not by the ſurgeons, but by the common people, the ſucceſs of which I was an eye-witneſs to in ſeveral caſes, as well as to the failure of the common mode of treating frozen parts by the moſt able ſurgeons of the army. I ſhall ſimply ſtate the facts I relate to.

After Ochakof was taken, I received into my ſubterranean lodging as many priſoners as it would contain, all of whom were either wounded or had a limb frozen. Among them were two children, one about ſix and the other about fourteen years of age; the latter had one of her feet frozen to the ancle, the other all the toes and the ſole of one of her feet. The ſecond day the parts appeared black, (the firſt day they were not much obſerved.) The French ſurgeon,

whom Prince Potemkin had ſent for purpoſely from Paris, and who was a man of note, ordered them to be conſtantly bathed with warm camphorated ſpirits: the elder was removed to the hoſpital, when a mortification began; the younger I kept, and as we removed into winter quarters, I carried the child along with me. The mortified parts ſeparated, the bones of the toes came off, and, after a conſiderable time, the ſores healed. I ſhould have ſaid, the ſurgeon was for immediately amputating both the limbs.

In a ſubterranean room, not far from mine, were ſeveral women whoſe feet had been in a like manner frozen; but as no ſurgeon attended them, the Ruſſian ſoldiers and waggoners undertook the cure. It was alſo the ſecond day when they applied their remedy, and the parts were perfectly black. This remedy was gooſe-greaſe, with which the parts were ſmeared warm, and the operation often repeated: their directions were, never to let the parts be dry, but always covered with greaſe. The conſequence was, that by degrees the circulation extended lower down, and the blackneſs decreaſed, till, laſt of all, the toes were only diſcoloured, and at length circulation was reſtored to them.

I can account for this no otherwiſe, than that the fat kept the pores ſhut, and prevented the air from promoting putrefaction; in the meantime the veſſels were continually abſorbing part of the ſtagnated blood, till by degrees the whole circulation was reſtored. It is known that extravaſated and ſtagnated blood will remain a long time in the body without putrifying, if it be not expoſed to the air. I conclude alſo, that in theſe caſes of froſt, the mortification firſt begins on the ſurface, which is in contact with the air.

I only meant, however, to relate facts, and leave it to others to account for them.

This is a general practice of the peaſants throughout all Ruſſia; but if a part is diſcovered to be frozen, *before the perſon comes into a warm room*, the froſt may be extracted by plunging the part into cold water, or rubbing it with ſnow till the circulation returns.

IV. *Account of the Method of Catching Wild Elephants at Tipura in the Eaſt Indies.* *By* JOHN CORSE, Eſq. *From* The Aſiatic Reſearches.

[Concluded from page 12.]

HAVING now related, partly from my own knowledge, and partly from comparing the accounts given by different people employed in this buſineſs, the manner in which the male elephants, called Goondahs, are ſecured; I ſhall next, entirely from my own knowledge, deſcribe the methods I have ſeen employed for ſecuring a herd of wild elephants. Female elephants are never taken ſingly, but always in the herd, which conſiſts of young and old of both ſexes. This noble, docile, and uſeful animal, ſeems naturally of a ſocial diſpoſition, as a herd in general conſiſts of from about 40 to 100, and is conducted under the direction of one of the oldeſt and largeſt females, called the Palmai, and one of the largeſt males. When a herd is diſcovered, about 500 people are employed to ſurround it, who divide themſelves into ſmall parties, called Chokeys, conſiſting generally of one Mahote and two Coolies, at the diſtance of twenty or thirty yards from each other, and form an irregular circle in which the elephants are incloſed: each party lights a fire and clears a foot-path to the ſtation that is next him, by which a regular communication is ſoon formed through the whole circumference from one to the other. By this path reinforcements can immediately be brought to any place where an alarm is given; and it is alſo neceſſary for the ſuperintendants, who are always going round to ſee that the people are alert upon their poſts. The firſt circle (the Dawkee) being thus formed, the remaining part of the day and night is ſpent in keeping watch by turns, or in cooking for themſelves and companions. Early next morning one man is detached from each ſtation, to form another circle in that direction where they wiſh the elephants to advance. When

it is finiſhed, the people ſtationed neareſt to the new circle put out their fires and file off to the right and left, to form the advanced party, thus leaving an opening for the herd to advance through; and by this movement, both the old and new circle are joined and form an oblong. The people from behind now begin ſhouting and making a noiſe with their rattles, tomtoms, &c. to cauſe the elephants to advance; and as ſoon as they are got within the new circle, the people cloſe up, take their proper ſtations, and paſs the remaining part of the day and night as before. In the morning the ſame proceſs is repeated; and in this manner the herd advances ſlowly in that direction where they find themſelves leaſt incommoded by the noiſe and clamour of the hunters, feeding, as they go along, upon branches of trees, leaves of bamboos, &c. which come in their way. If they ſuſpected any ſnare, they could eaſily break through the circle; but this inoffenſive animal, going merely in queſt of food, and not ſeeing any of the people who ſurround him, and who are concealed by the thick jungle, advances without ſuſpicion, and appears only to avoid being peſtered by their noiſe and din. As fire is the thing elephants ſeem moſt afraid of in their wild ſtate, and will ſeldom venture near it, the hunters always have a number of fires lighted, and particularly at night, to prevent the elephants coming too near, as well as to cook their victuals and keep them warm. The ſentinels ſupply theſe fires with fuel, eſpecially green bamboos, which are generally at hand, and which, by the crackling and loud report they make, together with the noiſe of the watchmen, deter the elephants from coming near; ſo that the herd generally remains at a diſtance near the centre of the circle. Should they at any time advance, the alarm is given, and all the people immediately make a noiſe and uſe their rattles to make them keep at a greater diſtance. In this manner they are gradually brought to the Keddah, or place where they are to be ſecured. As the natives are extremely ſlow in their operations, they ſeldom

bring the herd above one circle in a day, except on an emergency, when they exert themſelves and advance two circles. They have no tents or covering but the thick woods, which, during the day, keep off the rays of the ſun; and at night they ſleep by the fires they have lighted, upon mats ſpread on the ground, wrapt up in a piece of coarſe cloth. The ſeaſon is then ſo mild that the people continue very healthy; and an accident ſeldom happens except to ſtragglers about the outſkirts of the wood, who are ſometimes, though very rarely, carried off by tigers. The Keddah, or place where the herd is to be ſecured, is differently conſtructed in different places; here it conſiſts of three enclоſures, communicating with each other by means of narrow openings or gateways. The outer enclоſure, or the one next to the place where the elephants are to enter, is the largeſt; the middle one is generally, though not always, the next in ſize; and the third, or furthermoſt, is the ſmalleſt. Theſe proportions, however, are not always adhered to in the making of a Keddah, nor indeed does there appear to me any reaſon for making three enclоſures: but as my intentions are merely to relate facts, I ſhall proceed to obſerve, that when in the third or laſt enclоſure, the elephants are then only deemed ſecure; here they are kept ſix or eight days, and are regularly though ſcantily fed from a ſcaffold on the outſide, cloſe to the entrance of an outlet called the Roomee, which is about ſixty feet long and very narrow, and through which the elephants are to be taken out one by one. In many places this mode is not adopted; for, as ſoon as the herd has been ſurrounded by a ſtrong paliſade, Koomkees are ſent in with proper people, who tie them on the ſpot, in the ſame manner as was mentioned above of the Goondahs, or male elephants, that are taken ſingly. Theſe enclоſures are all pretty ſtrong; but the third is the ſtrongeſt, nor are the elephants deemed ſecure, as already obſerved, till they have entered it. This enclоſure has, like the other two, a pretty deep ditch on the inſide; and, upon the

the bank of earth, that is thrown up from the excavation, a row of ſtrong paliſades of middle-ſized trees is planted, ſtrengthened with croſs bars, which are tied to them about the diſtance of fourteen inches from each other; and theſe are ſupported on the outſide by ſtrong poſts like buttreſſes, having one end ſunk in the earth and the other preſſing againſt the croſs bars to which they are faſtened. When the herd is brought near to the firſt encloſure, or Baigcote, which has two gateways towards the jungle, from which the elephants are to advance, (theſe, as well as the other gateways, are diſguiſed with branches of trees and bamboos ſtuck in the ground ſo as to give them the appearance of a natural jungle,) the greateſt difficulty is to get the herd to enter the firſt or outer encloſure; for, notwithſtanding the precautions taken to diſguiſe both the entries as well as the paliſade which ſurrounds this encloſure, the Palmai, or leader, now appears to ſuſpect ſome ſnare, from the difficulty and heſitation with which in general ſhe paſſes into it; but, as ſoon as ſhe enters, the whole herd implicitly follows. Immediately, when they are all paſſed the gateway, fires are lighted round the greateſt part of the encloſure, and particularly at the entries, to prevent the elephants from returning. The hunters from without then make a terrible noiſe by ſhouting, beating of tomtoms (a kind of drum), firing blunt cartridges, &c. to urge the herd on to the next encloſure. The elephants, finding themſelves enſnared, ſcream and make a noiſe; but, ſeeing no opening except the entrance to the next encloſure, and which they at firſt generally avoid, they return to the place through which they lately paſſed, thinking perhaps to eſcape, but now find it ſtrongly barricaded; and as there is no ditch at this place, the hunters, to prevent their coming near and forcing their way, keep a line of fire conſtantly burning all along where the ditch is interrupted, and ſupply it with fuel from the top of the paliſade; and the people from without make a noiſe, ſhouting and

hallooing, to drive them away. Whenever they turn, they find themſelves oppoſed by burning fires, or bundles of reeds and dried graſs, which are thruſt through the opening of the paliſades, except towards the entrance of the ſecond encloſure, or Doobraze-cote. After traverſing the Baigcote for ſome time, and finding no chance of eſcaping but through the gateway into the next encloſure, the leader enters, and the reſt follow: the gate is inſtantly ſhut by people who are ſtationed on a ſmall ſcaffold immediately above it, and ſtrongly barricaded, fires are lighted, and the ſame diſcordant din made and continued, till the herd has paſſed through another gateway into the laſt encloſure, or Rajecote, the gate of which is ſecured in the ſame manner as the former was. The elephants, being now completely ſurrounded on all ſides, and perceiving no outlet through which they can eſcape, appear deſperate, and in their fury advance frequently to the ditch in order to break down the paliſade, inflating their trunks, ſcreaming louder and ſhriller than any trumpet, ſometimes grumbling like the hollow murmur of diſtant thunder; but wherever they make an attack, they are oppoſed by lighted fires, and by the noiſe and triumphant ſhouts of the hunters. As they muſt remain ſome time in this encloſure, care is always taken to have part of the ditch filled with water, which is ſupplied by a ſmall ſtream, either natural, or conducted through an artificial channel from ſome neighbouring reſervoir. The elephants have recourſe to this water to quench their thirſt and cool themſelves after their fatigues, by ſucking the water into their trunks, and then ſquirting it over every part of their bodies. While they remain in this encloſure, they continue ſulky, and ſeem to meditate their eſcape; but the hunters build huts, and form an encampment as it were around them, cloſe to the paliſade; watchmen are placed, and every precaution uſed to prevent their breaking through. This they would ſoon effect, if left to themſelves, notwithſtanding the

paliſade

paliſade is made of very ſtrong ſtakes ſunk into the earth on the outſide of the ditch, and ſtrengthened by croſs bars and buttreſſes as already mentioned.

When the herd has continued a few days in the Keddah, the door of the Roomee is opened, into which ſome one of the elephants is enticed to enter, by having food thrown firſt before, and then gradually further on into the paſſage, till the elephant has advanced far enough to admit of the gate's being ſhut. Above this wicker-gate, or door, two men are ſtationed on a ſmall ſcaffold, who throw down the food. When the elephant has paſſed beyond the door, they give the ſignal to a man who from without ſhuts it by pulling a ſtring, and they ſecure it by throwing two bars that ſtood perpendicular on each ſide, the one acroſs the other thus ×, forming the figure of St. Andrew's Croſs; and then two ſimilar bars are thrown acroſs each other behind the door next to the Keddah, ſo that the door is in the centre: for farther ſecurity, horizontal bars are puſhed acroſs the Roomee, through the openings of the paliſades, both before and behind thoſe croſſes, to prevent the poſſibility of the door's being broken. The Roomee is ſo narrow that a large elephant cannot turn in it; but as ſoon as he hears the noiſe that is made in ſhutting the gate, he retreats backwards, and endeavours to force it: being now ſecured in the manner already noticed, his efforts are unavailing. Finding his retreat thus cut off, he advances and exerts his utmoſt force to break down the bars, which were previouſly put acroſs a little farther on in the outlet, by running againſt them, ſcreaming and roaring, and battering them, like a ram, by repeated blows of his head, retreating and advancing with the utmoſt fury. In his rage he riſes and leaps upon the bars with his fore-feet, and ſtrives to break them down with his huge weight. In February 1788 a large female elephant dropt down dead in the Roomee, from the violent exertions ſhe made. When the elephant is ſomewhat fatigued by

theſe exertions, ſtrong ropes * with running nooſes are placed in the outlet by the hunters; and as ſoon as he puts a foot within the nooſe, it is immediately drawn tight and faſtened to the paliſades. When all his feet have been made pretty faſt, two men place themſelves behind ſome bars that run acroſs the Roomee to prevent his kicking them, and with great caution tie his hind-legs together, by paſſing a cord alternately from the one to the other, like the figure 8, and then faſtening theſe turns as above deſcribed. After this the Pharah, Dools, &c. are put on in ſucceſſion, in the ſame manner as on the Goondah, only that here the people are in greater ſecurity. While theſe ropes are making faſt, the other hunters are careful not to go too near, but keep on the outſide of the paliſade, and divert his attention as much as they can from thoſe employed in faſtening them, by ſupplying him with graſs, and ſometimes with plantain-leaves and ſugar-canes, of which he is remarkably fond, by preſenting a ſtick, giving him hopes of catching it, or by gently ſtriking or tickling his proboſcis. He frequently, however, ſeizes the ropes with his trunk, and endeavours to break them, particularly thoſe with which his feet are tied, and ſometimes tries to bite them through with his grinders (as he has no inciſors or front teeth); but the hunters then goad him with ſharpened bamboos, or light ſpears, ſo as to make him quit his hold. Thoſe who are employed in putting the ropes around his body, and over his head, ſtand above him, on a ſmall kind of platform, conſiſting of a few bars run acroſs through the openings of the paliſades; and as an elephant cannot ſee any thing that is above, and rather behind his head, they are very little incommoded by him, although he appears to ſmell them, and endeavours to catch them with his trunk. When the whole apparatus is properly ſecured, the ends of the two cables (Dools) which

* Theſe are of the ſame form and ſize nearly as the Phands, but much ſhorter in proportion.

were

were faſtened round his neck, are brought forward to the end of the Roomee, where two female elephants are waiting; and to them theſe cables are made faſt. When every thing is ready, the door at the end of the outlet is opened, the croſs bars are removed, and the paſſage left clear. The ropes that tied his legs to the paliſades are looſened, and, if he does not advance readily, they goad him with long poles ſharpened at the ends or pointed with iron, and urge him on with their noiſe and din, and at the ſame time the females pull him gently forward: as ſoon as he has cleared the Roomee, his conductors ſeparate; ſo that if he attempts to go to one ſide, he is prevented by the elephant that pulls in the oppoſite direction, and *vice verſa*. The Bundahs which tie his hind legs, though but looſely, yet prevent his going faſt; and, thus ſituated, he is conducted like an enraged bull, that has a cord faſtened to his horns on each ſide, ſo that he cannot turn either to the right or left to avenge himſelf. In like manner is this noble animal led to the next tree, as the Goondahs before mentioned were. Sometimes he becomes obſtinate, and will not advance; in which caſe, while one of his conductors draws him forward, the other comes behind and puſhes him on: ſhould he lie down, ſhe puts her ſnout under and raiſes him up, ſupporting him on her knee, and with her head puſhing him forward with all her ſtrength; the hunters likewiſe aſſiſt by goading him, and urging him forward by their noiſe and din; ſometimes they are even obliged to put lighted torches near, in order to make him advance. In conducting ſmall elephants from the Roomee, only one cable and one Koomkee are made uſe of. As ſoon as each elephant is ſecured, he is left in charge to the Mahote, or keeper, who is appointed to attend and inſtruct him; and, under him, there are from two to five Coolies, according to the ſize of the elephant, in order to aſſiſt and to ſupply food and water, till he becomes ſo tractable as to bring the former himſelf. Theſe people erect a ſmall hut immediately before him, where the Mahote,

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or one of the Coolies, conſtantly attends, ſupplies him with food, and ſoothes and careſſes him by a variety of little arts. Sometimes the Mahote threatens and even goads him with a long ſtick pointed with iron, but more generally coaxes and flatters him, ſcratching his head and trunk with a long bamboo ſplit at one end into many pieces, and driving away the flies from any ſores occaſioned by the hurts and bruiſes he got by his efforts to eſcape from the Roomee. This animal's ſkin is ſoft, conſidering his great ſize; is extremely ſenſible, and is eaſily cut or pierced, more ſo than the ſkin of moſt large quadrupeds. The Mahote likewiſe keeps him cool, by ſquirting water all over him, and ſtanding without the reach of his trunk: in a few days he advances cautiouſly to his ſide, and ſtrokes and pats him with his hand, ſpeaking to him all the while in a ſoothing tone of voice, and in a little time he begins to know his keeper and obey his commands. By degrees the Mahote becomes familiar to him, and at length gets upon his back from one of the tame elephants, and, as the animal becomes more tractable, he advances gradually forward, towards his head, till at laſt he is permitted to ſeat himſelf on his neck, from which place he afterwards regulates and directs all his motions. While they are training in this manner, the tame elephants lead out the others in turn, for the ſake of exerciſe, and likewiſe to eaſe their legs from the cords with which they are tied, and which are apt to gall them moſt terribly unleſs they are regularly ſlacked and ſhifted. In five or ſix weeks the elephant becomes obedient to his keeper, his fetters are taken off by degrees, and generally in about five or ſix months he ſuffers himſelf to be conducted by the Mahote from one place to another: care, however, is always taken not to let him approach his former haunts, leſt a recollection of the freedom he there enjoyed ſhould induce him again to recover his liberty. This obedience to his conductor ſeems to proceed partly from a ſenſe of generoſity, as it is in ſome meaſure voluntary; for, whenever

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an elephant takes fright, or is determined to run away, all the exertions of the Mahote cannot prevent him, even by beating or digging the pointed iron hook into his head, with which he directs him; on such an occasion the animal seems to disregard these feeble efforts, otherwise he would shake or pull him off with his trunk, and dash him in pieces. Accidents of this kind happen almost every year, especially to those Mahotes who attend the large Goondahs; but such accidents are in general owing entirely to their own carelessness and neglect. It is necessary to treat the males with much greater severity than the females, to keep them in awe; but it is too common a practice among the Mahotes, either to be negligent in using proper measures to render their elephants docile, or to trust too much to their good nature before they are thoroughly acquainted with their dispositions. The iron hook, with which they direct him, is pretty heavy, about sixteen inches long, with a straight spike advancing a little beyond the curve of the hook, so that altogether it is exactly like that which ferrymen or boatmen use fastened to a long pole.

In this account of the process for catching and taming elephants, I have used the masculine gender to avoid circumlocution, as both males and females are treated in the same manner: the former are seldom so docile, but, like the males of other animals, are fiercer, stronger, and more untractable than the females.

Before I conclude, it may be proper to observe, that young elephants suck constantly with their mouths, and never with their trunks *, as Buffon has asserted; a conclusion he made merely from conjecture, and the great and various uses to which they are well adapted and applied by every elephant.

* Aristotle says expressly, that the young elephants suck with their mouths, and not with their trunks: Ὁ δὲ σκυμνὸς ὅταν γένηται θηλάζει τῷ στόματι οὐ τῇ μύκτηρι. Aristot. Opera. Basiliæ 1500. fol. p. 494. EDIT.

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I have ſeen young ones from one day to three years old ſucking their dams, but never ſaw them uſe their trunks, except to preſs the breaſt, which, by natural inſtinct, they ſeemed to know would make the milk flow more readily. The mode of connection between the male and female is now aſcertained beyond the poſſibility of a doubt; as Mr. Buller, Lieut. Hawkins, and many others, ſaw a male copulate with a female, after they were ſecured in the Keddah, in a manner exactly ſimilar to the conjunction of the horſe with a mare.

This fact entirely overturns what has been ſo often related concerning the ſuppoſed delicacy of this uſeful animal, and a variety of other hypotheſes, which are equally void of foundation. As far as I know, the exact time an elephant goes with young, has not yet been aſcertained, but which cannot be leſs than two years, as one of the elephants brought forth a young one twenty-one months and three days after ſhe was taken. She was obſerved to be with young in April or May 1788, and ſhe was only taken in January preceding; ſo that it is very likely ſhe muſt have had connection with the male ſome months before ſhe was ſecured, otherwiſe they could not diſcover that ſhe was with young, as a fœtus of leſs than ſix months cannot well be ſuppoſed to make any alteration in the ſize or ſhape of ſo large an animal. The young one, a male, was produced October 16th, 1789, and appeared in every reſpect to have arrived at its full time. Mr. Harris, to whom it belongs, examined its mouth a few days after it was brought forth, and found that one of its grinders on each ſide had partly cut the gum. It is now alive and well, and begins to chew a little graſs.

I have further to remark, that one of the tuſks of the young elephant has made its appearance; ſo that we can now aſcertain it to be of that ſpecies called Mucknah, the tuſks of which are always ſmall, and point nearly ſtraight downwards.

downwards. He was thirty-five inches high at his birth, and is now thirty-nine; ſo that he has grown four inches in nearly as many months. Elephants are always meaſured at the ſhoulder; for the arch or curve of the back, of young ones particularly, is conſiderably higher than any other part, and it is a ſure ſign of old age whenever this curve is found flattened or conſiderably depreſſed, after an elephant has once attained his full growth.

Though theſe remarks, as well as ſeveral others in the above relation, do not come within the plan I propoſed, which was merely to deſcribe the method of taking wild elephants in the province of Tipura, yet I hope they will not be deemed impertinent or ſuperfluous, eſpecially as ſeveral of them tend to eſtabliſh ſome important facts in the natural hiſtory of this animal, that are not known, or not attended to, at leaſt in any accounts that I had an opportunity of ſeeing.

V. *Obſervations on the bodily Conformation and mental Capacity of the Negroes. By Profeſſor* BLUMENBACH. *From* Magazin für das neueſte aus der Phyſik, *Vol. IV.*

DURING a tour which I made through Swiſſerland, I ſaw in the picture-gallery at Pommersfeld four negro heads by Vandyk, two of which in particular had the lines of the face ſo regular that the features ſeemed very little different from the European. At that time, as I had never had an opportunity of acquiring a proper knowledge reſpecting the form of the negro head and cranium, by ſtudying nature, and as I remembered that Mr. Camper, in a diſſertation read in the Academy of Painting at Amſterdam, had mentioned that the greater part of the moſt eminent painters, and eſpecially Rubens, Vandyk and Jordaens, when they painted Moors, copied from Europeans, whoſe faces had been blackened for that purpoſe, I aſcribed the European look of the

above negro heads to this common fault. Some months after, however, I had an opportunity of convincing myſelf that there are real negroes whoſe features correſpond very nearly with thoſe of the Europeans, and that the above heads in the gallery of Pommersfeld might be a true repreſentation of nature.

Going to pay a viſit at Yverdun to the two brothers Treytorrens, one of whom, the chevalier, had been thirty-five years in the French ſervice, particularly at St. Domingo; and the other, by means of the opportunities which his brother enjoyed, had a collection of natural curioſities that contained many rare articles, when I entered the court of their elegant habitation, which is ſituated on the road to Goumoens, I ſaw no perſon to ſhew me into the houſe, except a woman of an agreeable figure, who was ſtanding with her back towards me. When ſhe turned round to give me an anſwer, I was much ſurpriſed to find that ſhe was a female negro, whoſe face perfectly correſponded with her figure, and fully juſtified the fidelity of likeneſs in Vandyk's negro heads, which I had ſeen at Pommersfeld. All the features of her face, even the noſe and lips, the latter of which were a little thick, though not ſo as to be diſagreeable, had they been covered with a white ſkin, muſt have excited univerſal admiration. At the ſame time ſhe was not only exceedingly lively, and poſſeſſed a ſound underſtanding; but, as I afterwards learned, was extremely well informed and expert in the obſtetric art. The handſome pretty negreſs of Yverdun is celebrated far and near as the beſt midwife in the Italian part of Swiſſerland. I was informed by her maſter, the chevalier, who has in his ſervice alſo a negro man as elegantly formed as a ſtatue, that ſhe was a creole from St. Domingo; that both her parents were natives of Congo, but not ſo black as the negroes of Senegal.

Since that period I have had an opportunity of ſeeing and converſing with many negroes, and have procured for my collection a great many anatomical preparations from negro bodies,

bodies, which, together with what I have read in different voyages, tend more and more to convince me of the truth of the two following propoſitions:

1. That between one negro and another there is as much (if not more) difference in the colour, and particularly in the lineaments of the face, as between many real negroes, and other varieties of the human ſpecies.

2. That the negroes, in regard to their mental faculties and capacity, are not inferior to the reſt of the human race.

The three negro ſkulls, which I have now before me, afford, by the very ſtriking gradation with which the lineaments paſs from the one to the other, a very evident proof of the firſt propoſition. One of them, which Mr. Michaelis was ſo good as to bring me from New-York, and of which I have given an accurate deſcription in another place *, is diſtinguiſhed by ſuch a projecting upper jaw-bone, that, if the ſame peculiarity belonged to all negroes, one might be tempted to ſuppoſe that they had another firſt parent than Adam. On the other hand, the lineaments of the third have ſo little of the exotic form, and are ſo different from the firſt, that if I had not diſſected the whole head perfectly entire, and juſt as it was when cut from the body, I ſhould be in doubt whether I ought to conſider it as having actually belonged to a real negro. The ſecond holds a mean rank between both, and in its whole form has a great likeneſs to the head of the Abyſſinian Abbas Gregorius, a good engraving of which by Heiſs, in 1691, from a painting by Von Sand, I have now before me, and which not only proves in general the cloſe affinity of the Abyſſinians with the negroes, but approaches much nearer to the ugly negroes, to ſpeak according to the European ideas of beauty, than the well-formed negreſs of Yverdún, or the handſome young negro whoſe head I diſſected as before mentioned, or than a thouſand others whoſe features are little different from thoſe of the Europeans. What I have here ſaid is indeed nothing elſe than a confirmation of a truth long

* In my Oſteology, p. 87.

known,

known, which has been already remarked by unprejudiced travellers, as will appear by the following quotations. Le Maire, in his Voyage to Cape Verd, Senegal, and Gambia *, says: "Blackness excepted, there are female negroes as well made as our ladies in Europe." Leguat, in his well-known Voyages †, tells us, that he found at Batavia several very pretty negresses, whose faces had the perfect European form. Adanson, in his Account of Senegal ‡, speaking of the female negroes there, has the following passage: "The women are almost as tall as the men, and equally well made. Their skin is remarkably fine and soft: their eyes are black and open; the mouth and lips small, and the features are well proportioned. Some of them are perfect beauties. They are exceedingly lively, and have an easy, free air, that is highly agreeable." Ulloa, in his *Noticias Americanas* ‖, observes, that some of the negroes have thick projecting lips, a flat nose, eyes deeply sunk in the sockets, which in general are called *getudos*, and wool instead of hair. He then adds: "Others, whose colour is equally black, have features perfectly like those of the whites, particularly in regard to the nose and the eyes, and smooth but thick hair §."

* Voyages aux Cap Verd, Senegal et Gambie, p. 161.

† Vol. ii. p. 136. ‡ Page 22. ‖ Page 92.

§ The following observations of an intelligent Danish traveller may serve still farther to confirm the truth of Professor Blumenbach's proposition: "Almost all the negroes are of a good stature, and the Akra negroes have remarkably fine features. The contour of the face, indeed, among the generality of these people, is different from that of the Europeans; but at the same time faces are found among them which, excepting the black colour, would in Europe be considered as beautiful. In common, however, they have something apish. The cheek-bones and chin project very much; and the bones of the nose are smaller than among the Europeans. This last circumstance has probably given rise to the assertion, that the negro women flatten the noses of their children as soon as they are born. But noses may be seen among some of them as much elevated and as regular as those of the Europeans. Their hair is woolly, curled and black, but sometimes red. When continually combed, it may be brought to the length of half a yard; but it never can be kept smooth. See P. E. Isert Reis na Guinea. Dordrecht 1790. p. 175. EDIT.

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The teſtimonies and examples which ſerve to prove the truth of the ſecond propoſition, reſpecting the mental faculties, natural talents and ingenuity of the negroes, are equally numerous and incontrovertible. Their aſtoniſhing memories, their great activity, and their acuteneſs in trade, particularly with gold duſt, againſt which the moſt experienced European merchant cannot be too much on his guard, are all circumſtances ſo well known, that it is not neceſſary to enlarge on them *. The great aptitude of the ſlaves for learning every kind of nice handicraft is equally well known; and the caſe is the ſame in regard to their muſical talents, as we have inſtances of negroes playing the violin in ſo maſterly a manner, that they gained ſo much money as enabled them to purchaſe their liberty †.

Of the poetical genius of the negroes inſtances are known among both ſexes. A female negro, who was a poeteſs, is mentioned by Haller; and a ſpecimen of the Latin Poetry of Francis Williams, a negro, may be found in the Hiſtory of Jamaica. The intereſting letters of Ignatius Sancho, a negro, are well known; and the two following inſtances will ſerve as a farther proof of the capacity and talents of our black brethren, in regard to literature and ſcience. The proteſtant clergyman J. J. Eliza Capitein was a negro; a man of conſiderable learning, and a great orator. I have in my poſſeſſion an excellent print of him engraved by Tanjé, after P. Vandyk. Our worthy profeſſor Hollman, when he was at Wittenberg, conferred the degree of Doctor of Phi-

* Barbot, in his Deſcription of the Coaſts of North and South Guinea, to be found in the fifth volume of Churchhill's Collection, relates many intereſting things on this ſubject. Thus he ſays, p. 235. "The blacks are for the moſt part men of ſenſe and wit enough, of a ſharp ready apprehenſion, and an excellent memory beyond what is eaſy to imagine; for, though they can neither read nor write, they are always regular in the greateſt hurry of buſineſs and trade, and ſeldom in confuſion."

† See Urlſperger's Americaniſch Ackerwerk Gottes, p. 311.

loſophy on a negro who had ſhewn himſelf to advantage, not only as a writer, but as a teacher, and who afterwards came to Berlin as a counſellor of ſtate to his Pruſſian majeſty. I have now before me two treatiſes written by him*, one of which, in particular, diſplays extenſive and well-digeſted reading of the beſt phyſiological works of the time. Of the uncommon knowledge which many negroes have had in the practice of medicine, very favourable teſtimony has been given by Boerhaave and De Haen, who were certainly competent judges; and the ſound ſkill and delicate expertneſs of the Yverdun accoucheuſe are, as already ſaid, celebrated throughout the whole neighbourhood.

To conclude, the Academy of Sciences at Paris had among the number of its correſpondents M. Liſlet a negro, in the Iſle of France, who excelled in making accurate meteorolo-

* One of them is entitled: *Diſſert. inaug. philoſophica de humanæ mentis απαθεια, ſive ſenſionis ac facultatis in mente humana abſentia, et earum in corpore noſtro organico ac vivo præſentia, quam* Præſ. D. MART. GOTTH. LOESCHERO *publicè defendit auctor* ANT. GUIL. AMO, Guinea-Afer, Phil. et A.A. L.L. Mag. et J. V. C. *Wittebergæ* 1734, *m. Apr.* The title of the other is: *Diſp. philoſophica, continens ideam diſtinctam eorum quæ competunt vel menti vel corpori noſtro vivo et organico, quam Præſide* M. ANT. GUIL. AMO, Guinea-Afro, *d.* 29. *Maii* 1734, *defendit* Jo. THEODOS, Meiner Rochliz-Miſnie. Philoſ. et J. V. Cultor. In an account of Amo's life, printed on this occaſion in name of the Academic Council, it is ſaid, among other things reſpecting his talents: "Honorem, meritis ingenii partum, inſigni probitatis, induſtriæ, eruditionis, quam publicis privatiſque exercitationibus declaravit, laude auxit—Compluribus philoſophiam domi tradidit excuſſis tam veterum, quam novorum, placitis, optima quæque ſelegit, ſelecta enucleatè ac dilucidè interpretatus eſt." And the preſident, in defending the firſt mentioned treatiſe, ſays expreſsly, in the annexed congratulation to Amo, "Tuum potiſſimum eminet ingenium feliciſſimum—utpote qui iſtius felicitatem ac præſtantiam, eruditionis ac doctrinæ ſoliditatem ac elegantiam, multis ſpeciminibus hactenus in noſtra etiam academia magno cum applauſu omnibus bonis, et in præſenti diſſertatione egregiè comprobaſti. Reddo tibi illam proprio marte eleganter ac eruditè elaboratam, integram adhuc et planè immutatam, ut vis ingenii tui eo magis exinde eluceſcat.

gical obſervations. On the other hand, whole provinces of Europe might, in my opinion, be named, from which it would be difficult to produce at preſent virtuoſo's, poets, philoſophers, and correſpondents of a learned academy.

VI. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth. By* M. DE SAUSSURE. *From* Journal des Mines. *No. XX.*

[Continued from page 41.]

CHAP. VI.

Obſervations to be made on Rivers and other Currents of Water.

1. EXTENT of their courſe, and their inclination from their ſources to their mouth.

2. Their dimenſions, breadth, depth and velocity in the different parts of their courſe.

3. Quantity of their periodical increaſe and decreaſe at different ſeaſons; their temperature during theſe ſeaſons; and the cauſes of theſe variations.

4. Limits and cauſes of their extraordinary inundations.

5. Whether they are navigable, and to what diſtance from their mouth?

6. The nature, purity, and ſalubrity of their waters.

7. The nature of the ſand or mud which they carry along with them; and to what diſtance they may be traced on the banks or at the bottom of the ſea where their mouths are ſituated. M. Beſſon even wiſhes that the traveller ſhould be furniſhed with a wooden veſſel (*ſebille*) to waſh the ſand and ſeparate the more ponderous particles, which may conſiſt of metal or precious ſtones. The motion of the waves is alſo

often ſufficient to ſeparate, in diſtinct bands or zones, particles of different gravity *.

8. Nature of the rolled pebbles found on their borders.

9. The quantity and kinds of fiſh by which they are characteriſed.

10. To enquire, as in regard to the ſea, whether it appears that they contain more or leſs water than formerly, and whether they have changed their courſes.

11. As the greater part of theſe queſtions may be applied to lakes, it is not neceſſary to make them the ſubject of a ſeparate chapter. I ſhall inſiſt only on their nature and the meaſure of their depth; on the temperature of their bottom compared with that at their ſurface in different ſeaſons; and alſo on the veſtiges of their extent and height in the remoteſt ages, compared with their preſent ſtate.

CHAP. VII.

Obſervations to be made on the Plains.

1. The extent, limits and inclination of a plain; its height above the level of the ſea; its relation with the hills or mountains by which it is bordered. To form a proper idea of it as a whole, it would be neceſſary to aſcend ſome eminence commanding a view over it.

2. The vegetable earth; its nature and thickneſs in different parts, compared with the time ſince it has been cultivated, with its productions, and the kind o culture. The nature of the baſis on which that earth reſts.

3. Rolled pebbles. (*See Chap.* VIII.)

4. Sand, argil; their nature; thickneſs of their beds.

5. Nature and thickneſs of the ſtrata of the earth at the greateſt depth poſſible to be reached, by taking advantage of the time when wells, mines and other excavations are dug.

* Moyens de rendre utiles les voyages des naturaliſtes. Eſprit des Journaux, Avril 1794.

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This research is particularly interesting when these excavations are extended below the level of the sea.

6. Marl-pits; their external appearances; whether they contain shells, and of what kinds; extent of their beds, and their thickness; analysis of them, at least with acetous acid; the uses for which the marl is employed.

7. Clay-pits; quarries of lime-stone, gypsum; mines of coal, &c.

8. Whether the plains exhibit at their surface, or contain in the interior parts of the earth, vestiges of marine bodies, petrified wood, bones or other substances foreign to the soil and to the country.

9. Internal temperature of the earth, ascertained either by direct experiments, or by observing that of the deepest wells or cellars; or by that of springs, which do not freeze in winter, and which remaining cool in summer, seem to come from the greatest depths.

10. Whether any fact can be observed which might oblige us to have recourse to the hypothesis of a central fire.

11. Basons surrounded by hills or mountains; whether they seem to have been formerly filled with water; whether the water appears to have been fresh or salt; whether any thing indicates the period of its retreat, and if there are any traces of the apertures through which it escaped.

CHAP. VIII.

Observations to be made on Rolled Pebbles.

1. The nature and size of those found in any particular district.

2. To examine, above all, whether there is any kind which may be considered as peculiar to that district, or which may be proper to characterise it; or even, whether the absence of any kind or class might not be sufficient to form that character.

3. Whether thoſe found on the borders of any river might be conſidered as having been thrown up by that river, or whether it only expoſed them to view by waſhing away the ſoil which it watered.

4. After eſtabliſhing the character of the pebbles of a certain diſtrict, one might follow, as it were, their traces, and form conjectures both reſpecting their origin and the route they have purſued.

5. The increaſe of their ſize will ſhew that they approach their origin, or *vice verſa*; but care muſt be taken that other veins of pebbles croſſing the former may not conceal the courſe of thoſe which you are tracing out.

6. A conſideration of the pebbles, and ſtill more that of rolled blocks, or, at leaſt, ſuch as are foreign to the ſoil which bears them; of the height at which they are found, and of the large valleys oppoſite to their preſent ſituation, may afford ſome indications of the direction, ſize and force of the currents produced by the grand revolutions of the earth.

7. A conſideration of thoſe blocks which reſt on ſolid rock, and which ſeem ſtill to occupy the place where they were depoſited, may, by the ſtate of theſe rocks, give an idea of the time elapſed ſince their arrival.

8. How far can the tranſportation of theſe great blocks to conſiderable diſtances be conſidered as a general phenomenon? or, is it only a particular phenomenon, ariſing from ſome local cauſe?

9. Can it be believed that ſuch of thoſe blocks as at preſent occupy elevated ſites on mountains, have been tranſported by billows or waves, which raiſed them gradually from the bottom of the valleys, and that they muſt at firſt have deſcended to theſe elevated ſituations *?

10. Or was it by enormous tides, of eight hundred toiſes

* May not the tranſportation of theſe blocks, at leaſt in cold countries, be aſcribed ſometimes to floating ice? C.

for

for example, that theſe blocks were tranſported to the tops of the mountains?

CHAP. IX.

On Mountains in general.

1. To conſider whether a mountain be inſulated, or whether it forms part of an aſſemblage of mountains connected with each other in the form of groups or chains.

2. If it be a group, to determine its form and dimenſions, and the manner in which its parts are connected.

3. If it be a chain, to determine its direction, its breadth, and its extent; whether it be ſingle or compound; and, in the latter caſe, the nature and diſpoſition of the partial chains which enter into its compoſition.

4. If a mountain be inſulated or conſidered ſeparately from its chain, or the group of which it forms a part, to determine its form, its height, and other dimenſions.

5. To determine the form and ſituation of its ſummit or moſt elevated part; thoſe of its declivities and bottom.

6. The ſituation of its precipices in regard to the ſea and the neareſt plains, valleys, and mountains *.

7. Its nature, and the kind of ſtone of which it is compoſed. Whether it be homogeneous; that is to ſay, of the ſame nature throughout all its parts; if it be not, to determine the dimenſions of its different parts.

8. Whether it conſiſts of indiviſible maſſes, or maſſes divided by ſtrata.

9. Whether it contains mines either in veins or ſtrata; the nature of theſe mines.

10. To obſerve the height at which the ſnow is perpetual, or what Bouguer calls *the lower limits of the ſnow*, and the height at which trees, ſhrubs, and plants, with diſtinct flowers, ceaſe to grow. Theſe obſervations have been neglected in the northern countries.

* And in regard to the four cardinal points; whether any ſide is more ſteep than another, and which ſide? C.

11. To obſerve carefully the increaſe or decreaſe of the glaciers: to determine them, in particular, by what are called *moraines*, that is to ſay, thoſe heaps of ſtones now or formerly depoſited by the glaciers on their edges and at their extremities.

11. A. To aſcertain whether there are found in the mountains ſunk or petrified trees, at heights at which they would not grow at preſent; and to examine if it thence follows that there may have been a time when the upper ſtrata of the atmoſphere were warmer than they are at preſent.

12. Caverns: if there are any, their form and dimenſions; the nature of their ſides; the nature and inclination of their bottom; veſtiges of the effects of the water by which they may have been formed; ſtalactites and incruſtations, foreign bodies and bones which they may contain.

13. Whether there are found veſtiges of large baſons diſpoſed in ſtories above each other, and which might have ſerved as reſervoirs to different ſeas that afterwards might have run off and united themſelves in the baſons of the preſent ſeas.

CHAP. X.

Obſervations to be made on the Strata of the Earth and Mountains.

1. The firſt queſtion is to determine whether a mountain or any maſs of earth and ſtone is or is not divided by ſtrata*.

2. What, in regard to the theory of the earth, gives importance to the queſtion, whether a mountain is or is not

* The word *ſtratum*, originally ſynonimous with that of *bed*, expreſſed the ſituation of a ſubſtance extended horizontally, and with an uniform thickneſs, on a plain and horizontal baſe. But the ſignification of this word has been enlarged, and it is now employed to expreſs the ſituation of ſubſtances extended with an equal or almoſt equal thickneſs on baſes which are neither plain nor horizontal. *Note of the Author.*

Might not the term *ſtratum* be reſerved for thoſe that are horizontal, and the name of *banks* be given to others? C.

ſtratified,

ſtratified, or compoſed of ſtrata, is the ſuppoſition that ſtratified mountains have been formed by the ſucceſſive depoſition of ſubſtances before ſuſpended in a fluid, while thoſe which exhibit no ſigns of ſtrata may be ſuppoſed to owe their origin to a ſimultaneous creation, or an accumulation not formed in a fluid, or which, at leaſt, had nothing ſucceſſive or regular, or in which there remain no traces of regularity.

3. If the mountain or maſs exhibits no marks of diviſion, the queſtion of its being ſtratified or not is ſuperfluous. We ſhall ſuppoſe then that it preſents diviſions, and require to know whether theſe diviſions may be called *ſtrata*. The ſolution of this queſtion depends upon three conſiderations: viz. The regularity of theſe diviſions, or their parallelism. Their number: the greater the number, the more it excludes the idea of fortuitous parallelism. The parallelism of theſe diviſions with the laminæ or parts diſcernible in the inſide of the maſs.

4. Though the ſtrata, in general, have the form of a parallelopipedon, ſome are ſeen cuneiform; in others are obſerved alternate ſwellings and conſtrictions; and others are ſeen ramified, dividing themſelves ſometimes into two or three, or two and three uniting and forming themſelves into one.

5. Beſides the form of the ſtrata, to obſerve their extent, either in the ſame mountain, or in ſeveral mountains near each other, or even at a diſtance.

6. To obſerve alſo their inclination, or the angle which they form with a horizontal line, and the point of the horizon to which their declivity is directed.

This laſt obſervation determines the direction of their planes, or the two oppoſite points of the horizon through which their planes would paſs, were they prolonged, after being made entirely ſtraight. This direction of the planes is of importance to be conſidered, eſpecially in vertical ſtrata.

7. To examine whether this direction is parallel, oblique or tranſverſe to the direction of the body itſelf of the mountain,

tain, the chain of which it makes a part, and the adjacent valleys.

8. To examine alſo whether the declivity of the ſtrata is conformable to that of the external ſurface of the mountain; that is to ſay, whether they deſcend towards the outſide of the mountain, or towards the interior part.

9. To examine next whether the inclination is the ſame from the bottom of the mountain to the ſummit, or whether it varies at different heights; whether it be the ſame or different at the oppoſite ſides of the ſame mountain. Strata in the form of a fan *.

10. It is of importance to obſerve, in inclined or vertical ſtrata, whether their thickneſs is not greater at their baſis than at their ſummit.

11. To obſerve the joinings of the ſtrata, and whether any ſubſtance different from that of the ſtrata is placed between them, and what is the nature and thickneſs of this ſubſtance.

12. To obſerve whether the contiguous or correſponding joinings of theſe ſtrata are ſmooth or unequal; whether there are obſerved in them any knots that exhibit traces of cryſtalliſation or undulations proceeding in a certain direction.

13. In mountains conſiſting of ſtrata different in their nature, or of different thickneſs, to obſerve whether their return is periodical, ſo that the ſame order recommences after a certain number or determined interval.

14. Whether, at the bottom of a mountain conſiſting of horizontal ſtrata, there are not found mountains compoſed of vertical ſtrata reſting againſt the baſis of that mountain.

15. In bent or circular ſtrata, to obſerve in the elbows or points where the flexion is greateſt, whether the ſtrata are or are not broken.

16. When the ſtrata have the form of a C, to obſerve whether at the back of the C there is not a vacuity, which proves that the upper part has been thrown above the under part.

* Voyages dans les Alpes, § 656 and 677.

17. To

17. To examine, in general, whether the ſtrata exhibit traces of violent convulſions, which may have changed their primitive ſituation; or, on the contrary, whether the whole, as well as the ſtraightening of the ſtrata, may be explained by ſimple ſinking down *.

CHAP. XI.

Obſervations to be made on Fiſſures.

1. Their form, dimenſions, breadth, extent, and direction.

2. Their ſituation; meaſure of their inclination; direction of that inclination in regard to the cardinal points, and in regard to the adjacent mountain and valleys.

4. To obſerve, above all, the direction of fiſſures in regard to that of the planes of the ſtrata; becauſe fiſſures, as is preſumed, being produced, in general, by the earth ſinking down, and this ſinking down being the effect of preſſure, fiſſures have been originally vertical or nearly ſo; and, on the other hand, becauſe the ſtrata having originally been horizontal or nearly ſo, the ſituation of fiſſures, in regard to the ſtrata, and the direction of both in regard to the horizon, may give ſome idea of the ſituation which the ſtrata had when the fiſſures were formed, and even of the changes of ſituation which the mountain afterwards experienced.

Thus, fiſſures perpendicular to the planes of the ſtrata, indicate that theſe fiſſures were formed when the mountain was ſtill in its primitive ſituation; and if they are alſo perpendicular to the horizon, it proves that the mountain is ſtill in the ſame ſituation: but if fiſſures perpendicular to the ſtrata are inclined to the horizon, we may conclude that the mountain has changed its ſituation ſince theſe fiſſures were formed †.

* 18. To obſerve, whether, on approaching the high primitive mountains, the calcareous ſtrata do not ſeem to have been reverſed in a more violent manner. B.

† An explanation and application of theſe principles may be ſeen in my Travels, § 1048, 49, 50, and 1218.

5. When

5. When the fiſſures are filled with matter different from the body of the mountain, that matter is called a vein.

6. Laſtly, one muſt examine, in both ſides of the ſame fiſſure, whether the ſtrata correſpond at the ſame height, or whether the correſponding ſtrata are lower on one ſide than on the other. The firſt caſe indicates that the fiſſure has been produced by mere burſting aſunder; and the ſecond proves, beſides, a ſinking down of the earth *.

[To be continued.]

VII. *Obſervations on the Winter Sleep of Animals and Plants. By Profeſſor* FABRICIUS. *From* Magazin für das neueſte aus der Phyſik. *Vol. IX.*

THE ſo called winter ſleep is a very ſingular property of animals and plants; and though it occurs daily before our eyes, we are not able to explain the phenomena with which it is attended. In cold countries many animals, on the approach of winter, retire to their ſubterranean abodes, in which they bury themſelves under the ſnow, where they remain five or ſix months without nouriſhment or motion; nay, almoſt without circulation of their blood, which flows only ſluggiſhly and in the wideſt veſſels. Their perſpiration is almoſt imperceptible: but ſtill they loſe ſomething by it; as they enter their winter quarters in very good condition, and are exceedingly thin when they return from them.

Some animals enjoy their winter ſleep under the earth, and others concealed below the ſnow; ſome for the ſame purpoſe creep into the holes of rocks, and others below ſtones or the bark of trees. Some kinds, ſuch as ſwallows and frogs, can paſs the winter in marſhes under the water. In this ſtate many of thoſe expoſed to the ſeverity of the

* To obſerve whether this ſinking down has not always taken place on that ſide which looks towards the flat country. C.

open air are deſtroyed by the froſt when it is violent; and even ſome of thoſe which have buried themſelves ſhare the like fate.

Plants have their winter ſleep alſo; for, during the period of winter, their ſap flows towards the root, and the circulation of it, which is very ſlow, takes place only in the wideſt veſſels. Were the expanſion of the ſap in winter as conſiderable as in ſummer, it would burſt all the veſſels on being frozen.

Several obſervers have endeavoured to prove that this ſingular circumſtance is merely accidental; and, indeed, no difference is found in the internal organization of thoſe animals which have winter ſleep, and thoſe which have not. It is very remarkable that this property belongs in general to animals of prey. As theſe have far ſtronger powers of digeſtion, and ſtronger digeſtive juices, it would appear that abſtinence from food for ſeveral months would to them be hardly poſſible.

The bear, the bat and the hedge-hog have winter ſleep; but the white bear has not. As the latter is ſecured from the cold by his long hair, he finds nouriſhment in the dead whales and ſeals which are caſt on ſhore by the waves.

The earth worms have winter ſleep; but aquatic worms very ſeldom. Inſects, as well as their larvæ, have winter ſleep. Butterflies may be often ſeen fluttering about in the warm days of ſpring, after having ſpent the whole winter in that condition. Amphibious animals have winter ſleep, thoſe which live merely in the ocean excepted.

Few birds, on the other hand, are expoſed to this ſtate. The greater part of theſe, on the approach of winter, retire to a milder climate where they can find more abundant nouriſhment.

In Iceland the ſheep have winter ſleep, becauſe in that country they are ſuffered to range in perfect freedom. In the winter ſeaſon therefore they may be ſeen buried under the ſnow and in the buſhes, where it would be impoſſible for them to remain were they not in that condition.

VIII. *Experiments made to aſcertain the Compoſition of the Swediſh Stone Paper or Artificial Slate. By* J. G. Georgi. *From the* New Tranſactions of the Imperial Academy at Peterſburgh, *Vol. IV.*

THE invention of Arfuid Faxe, confirmed by many experiments tried at Carlſcrona, but not yet communicated to the public, for making a certain kind of artificial ſlate or ſtone paper, which may be procured at a ſmall expence, and can be employed inſtead of common ſlate, was announced and highly extolled a few years ago in ſeveral of the public journals. This ſubſtance was ſaid to have a great reſemblance to milled or paſte-board; to be of an iron-red, white, or yellow colour; to be very hard and ſtiff, but ſomewhat elaſtic; to be ſubject to no alteration even when immerſed in cold water for ſeveral months, or when boiled for ſeveral hours; to be hardened by expoſure to the air; to reſiſt fire a long time, and to burn ſlowly, after having experienced a great degree of heat, but, when left to itſelf, to become ſoon extinguiſhed.

It is evident, therefore, that this paper may be applied to various economical purpoſes, ſuch as ſheathing ſhips, which it would not only preſerve from rottenneſs, but alſo from being deſtroyed by worms; for guarding from fire the cooking places in ſhips and powder magazines, and, laſtly, for covering houſes and wooden buildings. To this it may be added, that plates of this paper fixed on with braſs nails, and done over at the joinings with cement, might be covered with ſome oil varniſh in ſuch a manner as to be altogether impenetrable to moiſture. We are told alſo that a ſmall building conſtructed of wood at Carlſcrona, and caſed over with ſtone paper, after being filled with combuſtibles and ſet on fire, reſiſted the effects of the flames and remained unhurt, and that the ſame experiment repeated at Berlin on a ſmaller building was attended with the ſame reſult. One great advantage of this ſtone-paper alſo is, that it is exceedingly

ingly light, and may in general be procured at a cheaper rate than any other materials for covering roofs, as a plate of it 23 inches in length and 14 inches in breadth coſts at Carlſcrona only two ſchellings Swediſh.

An invention of ſuch utility and importance ought therefore to excite the ingenious to attempt an imitation of it, in order that, if poſſible, it may be rendered more public. As ſoon as I obtained a ſpecimen of it from Sweden, I made experiments to try whether I could not diſcover the method of making it. The fragment which I firſt examined was a line in thickneſs. It was light, eaſily broken, and poſſeſſed all the properties above enumerated. As the analyſis by which M. Antic de Servin, at the requeſt of M. Crell, endeavoured to illuſtrate the nature of this paper, did not appear to me ſatisfactory, I ſubjected part of the ſpecimen ſent me to a farther examination, leaving a third portion entire for the ſake of compariſon.

After this examination the red ſtone-paper appeared to me to conſiſt of, 1. Martial-hole, which ſeemed to be equal to half its weight, and which, on account of the chalk perhaps, or calcareous earth with which it was mixed, produced a little effervescence with acids. Perhaps alſo there were ſome particles of another earth, the diſcovery of which would be of little importance to the object of this reſearch. 2. A vegetable matter of little weight, and ſimilar to that uſed in the making of common paper. This formed about a fourth part of the weight. 3. An animal glue, ſimilar to that which is procured by boiling from various animal ſubſtances: and, 4. A certain oil which ſeemed to have a reſemblance to linſeed oil. Theſe ſubſtances (3 and 4) made about a fourth part of the weight.

Another ſpecimen which I received from Mr. Cameron, architect to her imperial majeſty, contained the ſame ſubſtances in proportions a little different. I was, however, not able to obtain ſpecimens of the white and yellow ſtone-paper,

in

in which M. Servin obſerved ſome traces of martial vitriol (*ſulphat of iron*).

Though I made a number of experiments in order to diſcover the compoſition of this ſlate, I ſhall here mention thoſe only which were attended with the beſt ſucceſs. But, to avoid repetition, I ſhall firſt deſcribe that previous manipulation which appeared moſt convenient.

The red or white bole, carpenter's ochre and chalk, which I employed for this uſe, were reduced to a fine powder. A pulpy maſs of the coarſeſt kind, procured from a paper-manufactory, after being macerated in water, was ſtrongly preſſed and weighed out for uſe. The weight was increaſed about two-thirds by the moiſture. In giving an account of the following experiments, I ſhall mention the weight of this ſubſtance as alluding to it when dry.

The glue was diſſolved in a moderate quantity of water. I added martial vitriol undiſſolved, and employed unboiled linſeed oil.

For want of a ſufficient quantity of raw pulp, I procured, for ſome experiments, fragments of coarſe old paper and book-binder's ſhavings, which, after being boiled for about three hours, were much tenderer than that brought from the paper manufactory. A pound of this when wet, after it had been preſſed, exceeded that which was dry by about two-thirds.

The pulp procured from a paper manufactory being mixed in a mortar with the diſſolved gluten, and being afterwards formed into a paſte by the addition of the above earths and ſulphat of iron, was well beat up in the mortar, and linſeed oil then poured over it. The maſs, being prepared in this manner, was ſpread out with a ſpatula above a ſheet of coarſe paper placed on a board furniſhed with a rim or border; another ſheet of the ſame paper was then ſpread over it, and a ſecond board was placed above all. The whole being then inverted, the board with the rim was taken off, and then the

firſt

firſt ſheet of paper. The compreſſed maſs was then laid over upon another board ſprinkled with ſand, and left to dry, after taking the ſheet of paper from its other ſide. Squares made in this manner dry without cracking; but as they become warped, it is neceſſary afterwards to flatten them, by putting them, with boards between, under a ſcrew-preſs, and letting them ſtand for ſome time.

Exp. I. I mixed an ounce and a half of the dry pulp from the mill with two ounces of common glue, and, having added red bole and ochre, of each two ounces, obtained a ſmooth plate.

II. To two ounces of pulp I added four ounces of red bole pulveriſed, and half an ounce of chalk, with an ounce and a half of glue. The plate thus produced was full of wrinkles and chinks, but tolerably hard.

III. An ounce and a half of pulp, with four ounces of bole, and two of ſulphat of iron, produced a plate equally hard, but uneven.

IV. An ounce of pulp procured from old paper and book-binder's ſhavings mixed, with half an ounce of glue, an ounce of powdered chalk, two of bole, and an ounce of linſeed oil, produced two thin plates ſmooth and hard.

V. Two ounces of pulp from the mill, with half an ounce of glue, ſix ounces of red bole and two of chalk, to which were added two ounces of ſulphat of iron, and the ſame quantity of linſeed oil, afforded plates that were ſmooth, but not ſtrong.

VI. An ounce and a half of pulp, with an ounce of glue, and four ounces of white bole, produced a plate ſmooth, beautiful, and hard.

VII. An ounce and a half of pulp, mixed with two ounces of glue, two ounces of white bole, and as much chalk, yielded a ſmooth plate as hard as bone.

VIII. An ounce of pulp, one ounce of glue, three ounces of white bole, and an ounce of linſeed oil, produced a plate ſufficiently perfect and elaſtic.

IX. A plate which I formed of an ounce of pulp, with half an ounce of glue, three ounces of white bole, an ounce of chalk, and an ounce and a half of linſeed oil, was ſuperior to that mentioned in the preceding experiment. This ſubſtance retains figures impreſſed upon it, and, tinged with half a dram of Pruſſian blue, aſſumed a blueiſh green colour.

X. An ounce and a half of pulp, with an ounce of glue and four ounces of chalk, afforded a plate exceedingly ſpongy.

XI. An ounce and a half of the ſame pulp, one ounce of ſulphat of iron, and four ounces of white bole, without glue, produced a plate yellowiſh and ſpongy.

XII. An ounce and a half of pulp, four ounces of white bole, with an ounce of ſulphat of iron, and the ſame quantity of glue, produced a yellowiſh plate a little more ſolid.

I tried ſeveral other mixtures; but as the plates they produced were of an inferior quality, I ſhall not give any account of them. The plates which had been prepared in the above manner I cut into ſeveral pieces, and daubed over a ſpecimen of each with boiled linſeed oil. The parts covered with the oil aſſumed a darker colour, and the ſuperficies acquired more ſolidity, nor were they leſs capable of reſiſting fire.

Being deſirous of comparing the productions of my experiments with ſpecimens of the Swediſh ſtone-paper, I macerated about an inch ſquare of each in cold water. After they had been macerated four months, the ſpecimens prepared with ſulphat of iron were conſiderably ſwelled, but thoſe made without linſeed oil ſeemed to have ſcarcely ſwelled at all. Thoſe, however, which I had daubed over with boiled linſeed oil or linſeed oil varniſh, exhibited as little appearance of change as the Swediſh.

I put a ſquare inch of each of the different kinds upon an iron ſpatula, together with a like quantity of beech wood, and expoſed the whole to a ſtrong heat in the mouth of a furnace. After fifteen minutes the wood began to burn, and in fifteen minutes more was reduced to aſhes. The

fragments

fragments of the different ſpecimens of the ſtone paper, expoſed to the ſame heat, were in ſuch a ſtate of ignition that they hiſſed when immerſed in water. I however examined them with great attention. The fragment of the Swediſh manufacture was ſomewhat black on the ſurface, and puffed up into ſmall bliſters; but did not ſeem to have burnt, or to have changed its form. The ſpecimens prepared with the ſulphat, being more ſpongy at the edges, burnt; but ſo ſlowly, that in thoſe of the worſt quality the fourth part was ſcarcely conſumed in the above time. All the reſt, inferior in nothing to the Swediſh ſpecimen, reſiſted the fire with equal ſtrength; ſo that moſt of them were only a little blackiſh on the ſurface, and entirely free from bliſters; nor did there appear any difference that could be aſcribed to the glue or linſeed oil employed, as they were all of the ſame conſiſtence, and none of them ſeemed to have been warped by the heat.

I then put ſome of the ſame fragments toaſted in the fire on a red-hot plate of iron, and immediately expoſed them for fifteen minutes to a ſtrong heat in the middle of a furnace. The Swediſh ſpecimen burnt, and for five minutes emitted a thick ſmoke; then appeared of a white heat for ſome time, and at the end of fifteen minutes was converted into three friable cineritious laminæ. The ſpecimen produced by my firſt experiment burnt in the courſe of a minute, kept up a flame for three minutes, and in fifteen minutes was converted into a black plate ſufficiently hard. Specimens of the ſecond, third and fourth experiments exhibited the ſame appearances. A plate produced by the fifth experiment was ſooner deſtroyed by the fire, and appeared friable like the Swediſh. A plate of the ſixth experiment, which before had been ſcarcely changed by the fire, bore the laſt expoſure exceedingly well; was ſcarcely changed in its form and magnitude, continued ſufficiently hard, and was only rendered black and as it were ſcorched. A ſpecimen of the ſeventh experiment burnt for a whole minute, and became

black and friable like the preceding. A ſpecimen of the eighth burnt for two minutes, and then continued black and ſufficiently hard. The ſame was the caſe almoſt with the ninth ſpecimen. A ſpecimen of the tenth, though it became black, was however ſcarcely changed. A fragment of the eleventh experiment burnt with a flame for about two minutes, and was converted into aſhes; which was the caſe alſo with the ſpecimen produced by the twelfth experiment.

Thoſe ſpecimens produced by my fourth, ſixth, ſeventh, eighth and ninth experiments, ſeemed to be the beſt in their external qualities and their power of withſtanding fire and water. The ſame fragments ſuffered as little from the influence of the weather and atmoſphere as the Swediſh. The materials for making this article may be readily procured for a ſmall price; and the proceſs is ſimple, and requires very little time. My ſpecimens indeed were not ſo neat and elegant as the Swediſh; but this inferiority may be obviated by practice and experience: and even in its imperfect ſtate the invention may be of great economical utility.

The cement which the Swedes recommend for filling up the interſtices between the ſquares, and of which I received a ſpecimen from Mr. Cameron, was compoſed of linſeed oil varniſh, white lead and chalk, mixed together in ſuch a manner as to approach to a fluid ſtate, that it might more eaſily inſinuate itſelf into the fiſſures.

As the chief uſe of this invention is to cover and incruſt houſes, I was deſirous of trying my production by expoſing it to the effects of the weather. I therefore nailed fragments of the Swediſh ſtone paper, and of that made by myſelf, to a ſmall board; and having daubed over the joinings with cement, I expoſed them in the month of Auguſt on the top of my houſe, and in the beginning of April the next year I found they had undergone no change.

IX. *On the ſo called Sea Froth and other Subſtances of which the Bowls of the Turkiſh Pipes are made. From a Letter written in Perſia by Dr.* REINEGG, *Correſpondent of the Royal Society at Gottingen, to* BARON VON ASCH *at Peterſburgh. Communicated to the Society by Profeſſor* BLUMENBACH.

THE ſo called ſea-froth (*lithomarga*), of which the bowls of the Turkiſh pipes are made, is not an artificial compoſition, but a natural kind of earth dug up near Konie in Natolia. This place, the ancient Iconium, lies in a moſt fruitful diſtrict, which may be truly called a terreſtrial paradiſe; and is celebrated on account of a large monaſtery of Derviſes founded by the Scheik Abid il Daher, but which received particular endowments from Sultan Suleiman, and in which at preſent there are two hundred Derviſes under the direction of a Scheik, by whom they are clothed and maintained.

The income of this monaſtery ariſes in part from ſome natural productions of that diſtrict, ſuch as marble, &c. and in particular from the above-mentioned yellowiſh white earth, of which the bowls of the Turkiſh pipes are made. It is dug up at Kiltſchik, (that is, the place of clay,) a village five miles diſtant from Konie; and beſides this I have heard of no other place, either in Natolia or along the coaſt of the Mediterranean ſea, where any of the like kind is produced. It is found in a large fiſſure ſix feet wide, in grey calcareous earth; and the workmen aſſert that the earth grows again in the fiſſure, and puffs itſelf up like froth. They therefore call it *kill-keffi*, or *kill-kefi*, a word which, if I read with Teſchdid, *kill-keffi*, ſignifies clay-froth, or light clay.

This earth, when it comes from the fiſſure, is heavy, ſoft and greaſy. It ſweats if thrown into the fire; produces a fetid vapour; grows hard, and becomes perfectly white. The freſh earth diſſolves in no acid. That which has been

burnt can be acted upon only by the nitrous acid; but not until the ſolution has been continued a conſiderable time in heat, and then it loſes nearly a third of its weight. When water is poured on the pure ſolution, it becomes a little muddy; and when it is ſuffered to evaporate entirely, a bitter ſalt exceedingly eaſy to be diſſolved is obtained. The undiſſolved earth, fuſed in a ſtrong fire, is converted into a brown ſlag. The freſh earth remains in water unchanged; and when it has been mixed with it by ſhaking and ſtirring, it falls again to the bottom, loſes its coheſion, and cannot be again uſed. The earth, after being burnt, imbibes a large quantity of water, throws out abundance of air bubbles, and becomes ſoft.

The peaſants of the village of Kiltſchik dig up a ſufficient quantity of this earth, for which they pay a certain ſum to the monaſtery, and then cut it into bowls for tobacco pipes. For the moſt part, however, they preſs the earth, while yet ſoft, into proper moulds in which the figures of various flowers have been cut; and while the bowls are in theſe moulds they bore the holes in them, and then lay the bowls in the ſun to dry. Some days after, when the ſurface of them is covered with a hard yellowiſh cruſt, they place the whole quantity of bowls in a heated baker's oven, and let them remain there till it is entirely cooled. They then boil them for an hour in milk; and when they are taken from it, they rub them with *Biſchik Kuirughi* (*equiſetum*) common horſe tail, in order to make them ſmooth and ſhining, which is at length completely effected by means of a piece of ſoft leather.

When the bowls have been prepared in this manner, and ſent to Conſtantinople for ſale, they are dyed there of different colours, partly by being boiled in wax or oil. The beſt mixture, however, is dragon's blood and nut-oil; for when the bowls have been well ſoaked in this mixture and penetrated by it, they acquire, in a ſhort time, a moſt beautiful dark-red dye. The Turks, however, in general are

not

not very fond of tobacco pipes made of ſea-froth: and they are ſeldom uſed by the Aſiatics; for they are too heavy, hold too much tobacco, and in ſome meaſure leſſen the agreeableneſs of its taſte. The Turks, therefore, prefer pipe-bowls made of red clay, and ſell the former chiefly to the Greeks, who tranſport them to Tranſilvania and Hungary.

Theſe ſmall red pipe bowls are, on the other hand, in common uſe throughout all Leſſer Aſia, Arabia, Egypt, &c. and are formed of a real kind of clay-earth; but in places where that clay-earth is not to be found, they are imitated by ſome artificial compoſition, which is indeed preferable; for thoſe burnt of clay have in general a pale red colour, whereas thoſe made artificially have a beautiful high colour. The earth of which theſe bowls are made is not a red bolus, but a blueiſh argillaceous ſpecies of potter's earth. Such, at leaſt, were thoſe which I ſaw at Trebiſond, Poli, and Cæſarea, where an immenſe number of theſe pipe-bowls are made.

In thoſe places, on the other hand, where this ſpecies of potter's earth cannot eaſily be procured, or is not valued, as at Conſtantinople and Tocat, the pipe-bowls are prepared in the following manner:—Small fragments of thoroughly burnt tiles, particularly old ones, are pounded and then reduced to fine powder in a mill. Three parts of this tile-duſt are then mixed with one part of any well waſhed argillaceous earth in pits made for the purpoſe, or in wooden boxes, and water to the height of a few inches is poured over it. This maſs is daily ſtirred during a week; the water is poured off and freſh water poured on every evening; at the end of the week the whole paſte is well ſtirred round with ſticks, and when the uſeleſs coarſe ſandy parts begin to ſink to the bottom, the remaining muddy water is drained off into other veſſels, where it is ſuffered to remain till the argillaceous paſte falls to the bottom and the water has again become clear. The remaining water is then carefully drained off, and the clayey cake, as it dries, is well kneaded. As ſoon as it is ſo dry as

to be fit for being worked, it is mixed with a ſomewhat leſs quantity of umber, and formed into pipe-bowls, either in a mould, or by being applied to the lath.

When theſe bowls have been ſufficiently burnt, they acquire a dark brown colour, which, however, changes into a beautiful red as ſoon as they have been well rubbed with a piece of leather ſprinkled over with fine pulveriſed blood-ſtone (*hematites*). Owing to this ſimple proceſs we obtain from the Eaſt thoſe red pipe-bowls, ſo much and ſo generally eſteemed, at a very low price, as five of them are generally ſold for a para *. When they are ornamented, however, with a gilt border, painted with golden flowers, enamelled or ſet with precious ſtones, one of them will coſt ſometimes two, three, and even four piaſtres †.

X. *A ſingular Phenomenon reſpecting Snow, ſome of which of a red Colour was found on the Alps. By* M. DE SAUSSURE. *From* Voyages dans les Alpes. *Vol. III.*

WHEN M. de Sauſſure explored mount Breven, for the firſt time, in the year 1760, he found in ſeveral places on a declivity ſnow ſtill remaining, and was not a little ſurpriſed to ſee the ſurface of it, in various parts, tinged with a very lively red colour. This colour was brighteſt in the middle of ſuch ſpots as had their centres more depreſſed than the edges, or where different planes covered with ſnow ſeemed to be joined to each other. When he examined this ſnow more cloſely, he remarked that its redneſs proceeded from a very fine powder mixed with it, and which had penetrated to the depth of two or three inches, but no farther. It did not appear that this powder had come from the higher parts of the mountain, becauſe ſome of it was found in places at a conſiderable diſtance from the rocks and much

* The value of a para is about three farthings.

† A piaſtre is equal to about half-a-crown.

lower

lower down; and it appeared alſo that it had not been conveyed thither by the winds, becauſe it was not diſpoſed in ſtripes or in the form of radii. The moſt probable conjecture therefore was, that it was a production of the ſnow itſelf, or the remains of its partial melting ſuſpended at its ſurface as in a filtre when the water paſſed through it. What ſeemed to favour this conjecture ſtill more, was, that the colour at the edges of the hollow places where little water had ſunk down was extremely faint; and, on the other hand, ſhewed itſelf ſtronger in thoſe parts where the greateſt quantity of water ſeemed to have penetrated.

M. de Sauſſure took a tumbler full of this ſnow, as he had no other veſſel with him, and held it in his hand till the ſnow melted, when he ſoon ſaw the red duſt depoſit itſelf at the bottom. Its colour then did not appear ſo dazzling as before, and when dry it loſt it entirely: it decreaſed alſo in quantity, ſo as almoſt to appear nothing.

Next year M. de Sauſſure aſcended the Breven, and found on it a quantity of the ſame kind of red ſnow, ſome of which he ſqueezed cloſely together and put into a large handkerchief, but before he got home it was entirely diſſolved by the heat of the ſun. It was not, however, on the Breven alone that he diſcovered ſnow of this kind; for he found of it on all the high mountains of the Alps, about the ſame ſeaſon of the year, and in ſimilar ſituations; ſo that he was much ſurpriſed that authors who had written reſpecting the Alps, ſuch as Scheuchzer, had made no mention of it. It is, indeed, true that it is found only in hollows, where the ſnow lies deep, and at a ſeaſon of the year when the melting of it has proceeded to a certain degree; for, when none of the ſnow or when very little of it has been melted, the duſt is then in too ſmall quantity to attract the eye; and if the melting has proceeded too far, the whole of the powder has paſſed through with the water, and it becomes equally inviſible. Beſides, towards the end of the melting, a great many foreign particles and impurities, conveyed thither by the

the wind, are mixed with it, ſo that its colour is no longer diſtinguiſhable.

In the year 1778, when M. de Sauſſure was on mount St. Bernard, he found a great deal of the ſame kind of ſnow. He collected as much of it as he poſſibly could; and Mr. Murrith, an experienced naturaliſt, collected of it alſo; ſo that they were enabled to make ſome experiments. On account of its great ſpecific gravity, M. de Sauſſure treated this red powder as an earth, firſt with diſtilled vinegar, but he employed ſo little that he had no reſult. He then boiled it in the muriatic acid, and obtained a ſolution, which, when carefully-diſtilled and filtred, had ſo brown a colour that he was quite at a loſs reſpecting the nature of this ſubſtance. He therefore applied it to the blow-pipe, and obſerved that it inflamed with a ſmell like that of burnt vegetables.

This experiment induced M. de Sauſſure to digeſt 40 grains of the powder in ſpirit of wine; and having filtered the ſolution, he found that the reſidue weighed 7 grains leſs: the ſpirit of wine had become of a golden yellow colour. He then diſtilled it in a balneum mariæ, and the ſpirit of wine came off perfectly pure. An oily tranſparent matter of a golden brown colour, which by the warmth of the balneum mariæ had not become dry, remained at the bottom of the retort. This oily matter had a ſmell like that of wax, which it emitted alſo when burning. The depoſit, which the ſpirit of wine had not diſſolved, was, in regard to its extractive part, alſo inflammable; and the aſhes which remained after it was burnt, though they did not ſeem alkaline, were fuſed by the blow-pipe into a porous kind of greeniſh glaſs.

Theſe experiments ſeem to prove that this powder was a vegetable ſubſtance, and probably the farina of ſome flower. M. de Sauſſure was acquainted with no plant in Swiſſerland that produced red farina in ſuch abundance as to tinge the ſnow of the Alps red; eſpecially when it is conſidered that a great deal of it muſt be loſt before it can reach the ſpots where

where the red ſnow is found. But the action of light, perhaps, may firſt give it its red colour; and in regard to its ſpecific gravity, that is not ſurpriſing, as by its long continuance on the ſnow it muſt, on account of the repeated ſlow meltings, receive ſuch an accumulation of particles as to become denſe and heavy.

M. de Sauſſure communicated his diſcovery to M. Bonnet, who adviſed him to examine the powder with a microſcope, in order to ſee whether it exhibited the appearance of the farina of flowers. He did ſo with the greateſt care and the beſt glaſſes, but he could not diſcover the leaſt regularity in its form.

Though M. de Sauſſure found this powder in different places on the Alps, he however aſks, whether it be very common, and whether it be found on the high mountains in different countries and different climates, ſuch, for example, as the Cordilleras? Theſe queſtions deſerve certainly to be examined; and though it be probable that this powder conſiſts of the farina of flowers, it is not altogether impoſſible that it may be an earth ſeparated by the ſnow itſelf, and poſſeſſing ſome inflammable properties called forth by the immediate action of the light and heat of the ſun, which ſhines with ſo much livelineſs in the pure air of theſe elevated regions.

XI. *Deſcription of an Apparatus propoſed to be applied to* M. KLINGERT'S *Diving Machine, to enable it to be uſed at greater Depths than it otherwiſe could.*

SOME doubts having occurred to the inventor of the diving machine, deſcribed in our laſt Number, reſpecting the practicability of employing it at very conſiderable depths, he was induced to propoſe an additional apparatus to render it more extenſively uſeful. The deſcription of this propoſed improvement we ſhall give in his own words; "Suppoſing it

it poſſible," ſays he, "to proceed to the greateſt depths with the before-deſcribed machine, difficulties may ſtill ariſe on account of the great length of the pipe; for it may be aſked, Can the diver breathe long when the column of air is of ſuch a length? I have found that it is difficult to breathe long through a pipe of a hundred feet, and half an inch in diameter; that the breaſt ſoon becomes fatigued; and that it is much eaſier to breathe through a pipe of half that length. Though a greater diameter may in part obviate this difficulty, ſo that the diver can breathe with more eaſe, yet another queſtion ariſes: At the depth of a hundred feet and more, is it poſſible for the diver to manage ſuch a long tube conveniently, as it muſt meet with reſiſtance according to particular circumſtances, and as by its length it muſt acquire conſiderable weight? How would he manage when he wiſhed to riſe again to the ſurface? and at ſuch a depth could he make a ſignal for that purpoſe, and with ſufficient quickneſs? On account of theſe queſtions I turned my thoughts to another machine, to be uſed in neceſſary caſes with the former, and I hope the one I mean to propoſe will be found worthy of ſome notice.

"The figure (Plate III.) repreſents the machine, which conſiſts of a hollow cylinder, terminating in two hollow truncated cones. It is conſtructed in the ſame manner as caſks, and made exceedingly ſtrong. In order that the wood may be rendered water-tight, it is daubed over on the outſide with any proper varniſh or cement.

"By means of the interior conſtruction of this machine a man can deſcend to a great depth in the water, and live and move freely without a pipe to ſupply him with atmoſpheric air, becauſe, being placed on a ſtage without the machine, and furniſhed with a harneſs and pipe like that before deſcribed, he can obtain air from the ſpace within it, which contains 58 cubic feet. He may, therefore, remain under water two hours; deſcend from the ſtage at pleaſure, move about with freedom, and, by means of the machinery

within,

within, rife and defcend when he thinks proper, as will appear from what follows :

" Thofe who have made experiments with air will not doubt that 50 cubic feet of it are fufficient to maintain the life of a man for two hours ; and the poffibility of afcending and defcending at pleafure may be thus explained :

" As this machine contains fuch a volume of air that it is lighter than water, it will require a conſiderable weight to make it fink below the furface. That as little, however, as poffible of the fpace deftined for containing air may be loft, lead may be employed, in the infide of the machine at *b*, fufficient to make it fink fo far that a cubic foot of it only fhall remain above the furface of the water. An additional weight then of 100 pounds will not only depreſs it below the furface of the water, but make it fink even to the bottom.

" But the fame thing may be effected without weights, by leffening the volume of the contained air. This is done by means of the piſton *c*, which fits clofely into the cylinder *d*, and which, by means of the rack *e*, the pinion *f*, the wheel *g*, and the endleſs ſcrew *h*, together with the winch *i*, can be moved either upwards or downwards.

" The machine, however, muſt not only be ſtrong and durable, but be conſtructed according to the depth to which it is deſtined to defcend and the preſſure on the piſton, that a man at ſuch a depth may have ſufficient ſtrength to depreſs it by means of the winch, and thereby to enlarge again the volume of air. It will readily appear that, by raiſing the piſton, the machine muſt ſink to the bottom ; and that, by depreſſing it, the machine muſt again afcend ; as was proved by a ſmall model which I made for that purpoſe.

" If a machine be conſtructed on a large ſcale, according to the proportions exhibited in the annexed figure, it will be found, by calculation, that, if we eſtimate the friction of the piſton, when made water-tight, at 200 pounds, and that of the wheel-work at 300, though it may perhaps not be ſo much, the winch at the depth of 120 feet will not require a

force

force of 40 pounds. If the diameter of the piſton, however, be leſſened, and the cylinder, in order that it may have the ſame cubic content, be lengthened, and if a larger wheel be added to gain more power, ſomething will be loſt in regard to time; but it can be eaſily calculated to what greater depth the machine may be uſed, and how much the ſtrength of a man can accompliſh. The higher the machine is in proportion to its diameter, the more ſecurely will it remain perpendicular in the water, and the leſs danger will there be of its being overturned; becauſe the diver is then nearer the centre of gravity. That the ſame advantage, however, may be obtained with leſs expence, the wheel work, together with the cylinder and piſton, may be omitted, and the machine conſtructed as far as the upper cover *o*; but it muſt be ſo furniſhed with hooks for ballaſt, that the diver, when he has previouſly ſcrewed on the pipe faſtened to the machine and placed himſelf on the ſtage, may hang on ballaſt, ſtones or other heavy ſubſtances, till it ſink, and, by throwing them away, may again aſcend at pleaſure. The machine in this form is ſimpler; and, in my opinion, to be preferred to the conſtruction with the piſton, wheel and rack, which I ſhall endeavour to prove in as mechanical a manner as poſſible.

"The ends of the pipe *l m*, which proceed into the machine, are ſo applied that all the particles of air may gradually proceed through the lungs. Should it, however, after being uſed two hours, be no longer capable of ſupporting life, the diver muſt aſcend with his machine, and be conveyed to the ſhip or boat attending him, by means of the rope faſtened to the ring *n*. He muſt then ſcrew off the pipe, open the top *o*, and, by means of a pair of bellows ſcrewed upon the mouth-piece, expel the air from the machine, and blow into it ſound atmoſpheric air for further uſe*.

* This is not an effectual way of removing the tainted air, which may be more ſimply, and at the ſame time completely effected, by immerſing it, when open, under water: on the pouring out of which afterwards, the machine would be filled with atmoſpheric air. EDIT.

"Two

"Two ſmall oars may be added to the ſtep or ſeat in order to make a few movements, and alſo an anchor or grapnel to faſten the machine to the bottom, that the diver may be enabled to walk about with the pipe at freedom, for the purpoſe of examining ſunk bodies, and diſcovering the propereſt method of raiſing them. For the greater ſecurity, in caſe any accident ſhould happen to the machine, an apparatus may be applied to the pipe, that the diver can leave the machine and riſe without it; which he might eaſily effect, by throwing away the weights ſuſpended from his harneſs, and by retaining between his body and harneſs a ſufficiency of air for aſcending. By theſe means he might leave the great machine, even if he were not acquainted with ſwimming. As ſoon as he roſe to the ſurface, he would obtain freſh vital air through the opening *g*. (*See Plate I. of the preceding Number.*)

"At *p* is a lantern, the uſe of which is to afford the diver light in the water; becauſe the ſolar light is prevented from penetrating to very great depths by the many foreign ſmall particles mixed with that fluid, and is therefore incapable of rendering bodies lying at the bottom of it viſible; and becauſe occaſions may occur when artificial light will be neceſſary.

"I have alſo prepared ſuch lanterns to be held in the hand; but, for particular reaſons, I muſt here abſtain from explaining their conſtruction, and only aſſure the public, on my veracity as an honeſt man, that they anſwer the intended purpoſe. A candle in theſe machines, which are very ſimple, will burn in every kind of air, in mines and pits, where all other lights are extinguiſhed. They contain a ſpace equal to a cubic foot; and the candle burns, without any new addition from without, for two or three hours: they endure all concuſſions of the air, and are deranged by no motion or working in mines. Their utility, therefore, in other reſpects may readily be conceived. I ſhall not fail, however, at another time, to make them publicly known, as well as all the previous circumſtances which led me to the diſcovery.

XII. *Singular Inſtance of the Attachment of Birds of Prey to their Young.* *By* M. CRONSTEDT. *From* New Tranſactions of the Royal Academy of Sciences at Stockholm, *Vol. X.*

MR. Cronſtedt reſided ſeveral years on a farm in Sudermania, near a ſteep mountain, on the ſummit of which two eagle-owls (ſtrix bubo L) had their neſt. One day, in the month of July, one of the young owls having quitted the neſt was caught by ſome of his ſervants. This bird, conſidering the ſeaſon of the year, was well feathered; but the down appeared here and there between thoſe feathers which had not yet attained their full growth. After it was caught, it was ſhut up in a large hen-coop, and next morning M. Cronſtedt found a young partridge lying dead before the door of the coop. He immediately concluded that this proviſion had been brought thither by the old owls, which no doubt had been making ſearch in the night-time for the loſt young one, and might have been led to the place of its confinement by its cry. This turned out to have been actually the caſe; for M. Cronſtedt found that the ſame mark of attention was repeated every night for fourteen days. The game which the old ones carried to it conſiſted chiefly of young partridges, for the moſt part newly killed, but ſometimes a little ſpoiled. One time a moor-fowl was brought to the young owl, ſo freſh that it was ſtill warm under the wings: a putrid ſtinking lamb was alſo brought. M. Cronſtedt ſuppoſes that the ſpoiled fleſh had already lain a long time in the neſt of the old owls, and that they brought it merely becauſe they had no better proviſion at the time. He and his ſervant tried to watch ſeveral nights, in order that they might obſerve through a window when this ſupply was depoſited; but their plan did not ſucceed, and it would appear that theſe owls, which are very ſharp-ſighted, had diſcovered the moment when the window was not watched, as food was found to have been depoſited for the young before the

the coop that very night. In the month of Auguſt this care ceaſed; but that period is exactly the time when all birds of prey abandon their young to their own exertions. It may be readily concluded, from this inſtance, how much game muſt be deſtroyed by a pair of theſe owls during the time that they rear their young. This obſervation is applicable to the whole race of owls, in general; and theſe may be conſidered therefore as the moſt deſtructive of all the birds of prey. As the eatable-birds of the foreſt repair chiefly in the night-time to the fields, they are particularly expoſed to the acute ſight, ſmell, and claws of theſe birds of the night; and even the ſwift-footed hare ſeldom eſcapes them.

XIII. *A ſhort View of the Mitchillian Theory of Fever, and of Contagious Diſeaſes in general.*

CERTAIN exhalations from marſhes and ſwamps, and from collections of putrefying vegetable and animal ſubſtances, induce diſeaſes attended with different degrees of malignity, according to circumſtances. There is a great ſimilarity at leaſt in the diſeaſes induced by the exhalations from marſhes and from putrefying ſubſtances: it ought to be ſo; for the noxious quality of the former is in conſequence of their containing the latter; and hence ſuch diſeaſes, though improperly, have been called putrid.

What is the peculiar ſubſtance, or what the ſubſtances in theſe exhalations that cauſe what are termed contagious diſeaſes? What the mode of action? Animal and many vegetable ſubſtances, eſpecially thoſe which contain gluten, give ſimilar products when decompoſed by the putrefactive proceſs.

Can hydrogen gas be the deleterious product? No—its baſe combined with different ſubſtances makes a great part of our aliment: with carbon it forms fat—with oxygen,

water—with azote, the volatile alkali (ammonia), uſed as a medicine.

Carbonic acid gas cannot poſſeſs a contagious quality, for it is continually generating where its effects would be moſt hurtful—in the lungs, from whence it is conſtantly emitted by expiration. We ſwallow it in great quantities in beer and other fermented liquors; and, combined with hydrogen gas, it may, as has been proved by the Engliſh pneumatic phyſicians, be taken in large doſes as a remedy for different diſeaſes.

Azotic gas forms nearly two thirds of the common atmoſphere we breathe: its baſe united to other ſubſtances compoſes a great portion of our food. Oxygen gas forms the other third—without it we cannot live.

Such gaſes therefore may be *mixed* with each other, and yet not be the cauſe of contagion. Where then is it to be ſought? In ſome *chemical union* between two or more of them, or their baſes, effected, by the operation of ſome cauſe, during their ſeparation from the organiſed body of which they formed a part, by the proceſs of putrefaction.

Permanently-elaſtic fluids owe their gaſeous form to a chemical union of caloric with their reſpective baſes. When this union is once effected, two gaſes may be mixed or blended together, as oil with water, or wheat with barley; but no chemical union can be effected between them, the attraction of the baſe of each for caloric being ſtronger than that of the gaſes for each other. When the affinity of their baſes for each other is ſtronger than for caloric, a chemical union of the baſes may take place; but in that caſe the caloric is ſet at liberty, and the product, inſtead of being gaſeous, is concrete, as when ammoniacal gas is preſented to carbonic acid gas.

But if the baſes act on each other before either be ſaturated with caloric, a chemical union may be effected between them: thus azote and oxygen will yield the nitrous acid.

acid. If caloric, as a third principle, unite itſelf, ſo as to ſaturate the oxygen and azote at the moment of their extrication, not to each reſpectively, but as entering chemically into union with each other, the reſult will be a gas holding the three ingredients chemically united, and conſequently poſſeſſing very different properties from a mixture of oxygen gas with azotic gas; for, in the latter caſe, the baſe of each having been previouſly ſaturated with caloric, both the gaſes by that means have been put into a ſtate that prevents the poſſibility of a chemical union taking place between them.

When a *mere mixture* of oxygen gas and azotic gas (atmoſpheric air) is inhaled into the lungs, the animal powers exert ſuch an action on the oxygen gas as to effect a ſeparation between the oxygen and caloric, applying each to the purpoſes intended by nature; while the greater part of the azotic gas is reſpired undecompoſed, mixed with the carbonic acid gas that has been generated by the union of a portion of the oxygen gas with carbon furniſhed by the animal, and with moiſture formed by a portion of the baſe of the oxygen gas with hydrogen, the caloric of that portion having gone to the ſupply of the animal heat. But if a gas compoſed of oxygen and azote *chemically combined* with each other and with caloric, be diffuſed through the atmoſphere inhaled, a ſubſtance is received into the lungs poſſeſſing very different chemical properties from common air; for, though the component principles be the ſame, being combined in a very different manner, it muſt poſſeſs a very different mode of action upon the animal. In fact, it may be taken into the ſyſtem in its combined ſtate, where, meeting with principles which poſſeſs a ſtronger affinity for ſome of its conſtituent parts than they do for each other, it may be decompounded; while, by the ſame operation, the animal fluids, or ſolids, or both, are themſelves decompounded, by parting with one or more of their principles which enter into the new combination.

Where ſuch a noxious gas abounds, it is no wonder that peſtilential diſeaſe ſhould be the conſequence, eſpecially if it ſhould prove miſcible in water, for then it will be taken in with the food and drink, and may even be abſorbed by the ſkin, as well as by the noſe, pallate and lungs.

The nitric acid, which is compoſed of oxygen and azote, poſſeſſes very different properties from atmoſpheric air, which is a mixture of theſe two each previouſly combined with caloric. It would be juſt as fair reaſoning to ſay that, their baſes being the ſame, they muſt poſſeſs the ſame properties, as to infer that the noxious gas above mentioned ſhould poſſeſs the ſame properties with atmoſpheric air, becauſe compoſed of the ſame ingredients.

Oxygen and azote, by certain operations of nature, enter into combination with other elements to form organiſed bodies. By this proceſs they are put into a ſituation which enables them to form a new union as ſoon as the laws by which the organiſed ſtructure maintains the harmony of the complex combination, ceaſe to exert their influence upon it. New affinities then begin to operate, and that ſpecies of decompoſition ſo well known by the name of putrefaction is the immediate conſequence. The oxygen and azote, during their extrication from the putrefying ſubſtance, may come within the ſpheres of each other's attraction, without entering into an intermediate ſtate of gas by union with caloric: and in this way it is probable ſome modification of nitrous gas, or the nitrous acid, is formed, according as caloric enters or not as a third ingredient into the compound.

As this gas, which the ſupporters of the preſent theory conſider as the matter of contagion, according to them, always owes its origin to the putrefaction of animal and vegetable ſubſtances, they have given it a name expreſſive of that origin. They aſſume the word *ſepton* to expreſs the radical of the nitrous acid, and derive it from σηπω, *putrefacio*; whence comes ſepton, *putridum*; and propoſe that the combinations formed

formed from the baſe of the nitrous acid may have new terms in the nomenclature, and be arranged in the following order:

Septon, for azote or nitrogen
Septous gas, for azotic gas
Gaſeous oxyd of ſepton, for dephlogiſticated nitrous air*
Septic gas, for nitrous gas
Septous acid, for nitrous acid
Septic acid, for nitric acid
Septat, ſeptite—for nitrat, nitrite, &c.

By inſiſting that the nitrous acid is of animal derivation, or from vegetables poſſeſſing the ſame principles, the Mitchillians only mean, that nature effects the decompoſition of azotic gas by the operation of thoſe laws which ſhe employs in forming organiſed bodies; that oxygen (not in combination with caloric) enters into the compoſition, and that during the deſtruction of ſuch bodies theſe principles unite with each other. By the affinity the product has for the vegetable alkali, which, or the principles that form it, is extricated from decaying vegetables, it joins it wherever it can find it, and produces nitre, the grand ſource from whence the nitrous acid is made.

To prove this poſition, the works of thoſe who have wrote on the production of nitre, and the nature of the ſoils where it is produced in the greateſt abundance, are examined, and from them the fact is endeavoured to be eſtabliſhed, that the putrefaction of organiſed ſubſtances is an indiſpenſible requiſite. Another fact is pointed out from the ſame ſource, and from medical writers, namely, that the neighbourhood of ſuch ſoils is extremely unhealthy, eſpecially at particular ſeaſons of the year, when circumſtances, in the firſt place, are ſuch as to favour quick putrefaction, and in the ſecond, to preſent the greateſt number of obſtacles to the ſeptic (nitrous) gas, being taken out of circulation by being neutraliſed.

* So named by Dr. Prieſtley, becauſe it can maintain combuſtion.

If ſuch be the fact, it offers a ſolution of the queſtion, Whence jails, hoſpitals, ſhips, and other crowded places, become infected with noxious vapours?—The animal exhalations, excretions, &c. go through the putrefactive proceſs in the ſame way that dead animal ſubſtances would, and the products are the ſame. One of them, the gaſeous oxyd of ſepton, being miſcible in water, lodges itſelf in the damp walls, where, after it has ſaturated ſuch of the ſubſtances it meets with as have affinity for it, it keeps accumulating, till ſome circumſtance, as hot weather for inſtance, drives it out with the evaporating moiſture, in ſuch quantity as to infect the atmoſphere.

That combination of ſepton (azote) with the acidifying principle which produces the gaſeous oxyd of ſepton, is not however conſidered as excluſively the only proportion of the ingredients that produce contagion. There are an infinity of gradations in the proportions in which theſe principles may be united, and yield a contagious fluid—the vapours of the nitric acid itſelf are not excepted. Theſe peſtilential fluids are conſidered as being always, even in their weakeſt form, ſomewhat of ſtimulants. In many inſtances moſt violently ſo. Though their operation is modified, when in a dilute form they impede reſpiration, or nauſeate the ſtomach, as they then bring on a diminution of action and energy amounting in the cold ſtage to a ſtate of direct debility: when applied in great quantity and force, they kill inſtantly; when in leſs quantity, they produce an anomalous diſeaſe, of the form of which Chiſholm's caſes preſent inſtances; when in a weaker ſtate, a common contagious catarrhal affection may be the conſequence; when inhaled in a form yet more diluted, a remitting or intermitting fever may be the diſeaſe induced, of the form of quotidian, tertian, or quartan, or any of their varieties; or the remitting may be called jail, hoſpital, ſhip, camp, army, yellow, putrid, or bilious, malignant, peſtilential, miliary, petechial, ardent, ſlow,

ſlow, continued, continual, dyſenteric, contagious or infectious, according to the circumſtances that may occur in the progreſs of the diſeaſe.

"The main difficulty left is to account for the cold fit of a regular tertian. This ſtage of fever I believe to depend upon impeded reſpiration, and the impeded reſpiration to depend upon the vitiated quality of the air taken into the lungs; or in ſome ſlighter caſes, where the ſtomach is originally thrown into a diſordered ſtate, the lungs, by aſſociation with that organ, are thrown into diſorder too, and for a time perform their functions but imperfectly.

"Thus I preſume it is that the impeded ſtate of reſpiration is attended with a ſmaller evolution of heat and oxygen in the lungs, and conſequently with more or leſs diminution in the circulation of the blood, and a proportionable degree of chilline's and coldneſs throughout the body. The duration and degree of the cold fit will correſpond to the continuance and power of the cauſes diſturbing the pulmonic organs, either by acting upon them directly or indirectly through the intermedium of the ſtomach.

"From the ſmall quantity of heat and oxygen communicated to the blood in the lungs, and the conſequent ſlow and feeble circulation of the blood, can the ſhrinking, paleneſs, tremors, coldneſs, debility, &c. &c. be ſufficiently explained, as the conſtitution is now deprived of its two chief ſtimulants.

"But why does not the continued operation of the vitiated air upon the lungs, or the aſſociated condition of the lungs with the ſtomach, go on in an increaſing ſeries even unto death? The power of our conſtitutions to become familiariſed to the action of noxious cauſes, is evinced by the innocent operation of poiſonous ſubſtances, which, by frequent repetition, grow gradually habitual, and by cuſtom loſe their primary operation. This diſpoſition to become familiariſed to vitiated airs, is apparent in the inhabitants of Africa, who are ſo ſeaſoned to the air and climate they live

in, that it excites no diſturbance at all in their conſtitutions, while ſtrangers fall victims in the greateſt abundance. Now, common intermitting paroxyſms are inſtances of temporary ſeaſonings, which the conſtitution experiences, of a kind quite analogous to what is perpetual with the Guinea negroes.

"The cold fit ſometimes does terminate in death; and this happens when the conſtitution cannot acquire the habit of enduring the noxious cauſe with impunity. In the generality of caſes, however, the ſtimulus of the infectious gas loſes its power to operate before the conſtitution is debilitated to death; and as ſoon as it becomes, for this time, ſo much accuſtomed to the vitiated air, as no longer to be diſturbed by its preſence, the cold fit ends. The length and violence of the cold fit will thus be, *cæteris paribus*, in a compound ratio of the impediment given to the reſpiration by the infectious gas, and the facility with which the conſtitution accommodates itſelf to its action: if three perſons then inhabit one houſe, it is poſſible that one may become ſo quickly accuſtomed to the air as to have no diſtemper; a ſecond may have a moderate diſeaſe of but a few fits; while the third, poſſeſſed of a conſtitution not eaſily moulded to a new habit, may be incommoded by a violent and obſtinate malady.

"In every paroxyſm of an intermittent, the infection thus wears itſelf out; but this is only a temporary reconcilement of the body to its action; when, after a repetition of fits, the diſorder becomes milder and milder, and after a while wholly ceaſes. This is a caſe of laſting reconcilement; and in this way may a large portion of ſmall intermittents cure themſelves, while the credit is given to the bark! This power of habit daily does wonders, and labours more effectually for the good of the ſick than bark, opium and antimony put together.

"The attack of theſe cauſes being thus for a time overcome, reſpiration grows free, full, and frequent; becauſe there

there is now a greater appetency in the conſtitution for heat; more vital air is decompounded in the lungs; and more ſtimulus is applied, by means of the increaſed heat and oxygen now in the blood, to the heart and arteries: theſe ſtimuli operate more powerfully on account of the accumulated excitability of the body; and a degree of excitement is thence induced, which ſometimes ends in death, ſometimes cauſes delirium, and in almoſt every caſe exceeds the healthy temperature.

"The duration and violence of the hot ſtage will be, *cæteris paribus*, in a compound ratio of the excitability accumulated in the cold ſtage, and the heat and oxygen evolved in the hot one. When the excitability is exhauſted by the operation of the ſtimuli, the violence of action will ceaſe, and the body grow cool.

"The doctrine of intermitting fever, then, is briefly this: the vitiated atmoſpheric fluid, by interfering with the pulmonic action, brings on the cold ſtage, and would continue the ſame until its termination in death, did not the conſtitution in the mean time acquire ſuch a habit as to gain a temporary inſenſibility to its action. This habit being induced, the cold ſtage abates by reaſon of the ſtate of direct debility into which the body had been brought; anxiety continues, and, by the quickening of reſpiration, heat and oxygen are ſet looſe in the lungs, and becoming incorporated with the blood, now warm and ſtimulate every part with more than uſual power, and occaſion the phænomena of the hot ſtage, which terminates as ſoon as the accumulated excitability of the ſyſtem is exhauſted.—The ſweating ſtage follows of courſe, as in other caſes of the ſubſidence of violent action: for, after a time, the exhauſted excitability of the animal ſyſtem allows exceſſive action to go on no longer; the reſpiration grows more moderate and eaſy; the heart beats with leſs frequency and force; the arterial contractions are alſo more ſlow and health-like; and, as the arterial contractions relax, the hydrogen and oxygen of the blood

blood now run together in the extreme veſſels of the ſkin, and form the moiſture which bedews the ſurface; and this afterwards flying off by evaporation, cools by degrees the whole body down to its ordinary temperature: and, as the arterial extremities of the reſt of the body become dilated by the ſubſidence of excitement, the other ſecretions, which had been generally ſuſpended during the fit, now return as before: after this, the conſtitution, ſo far accuſtomed to the breathing ſuch an atmoſphere, regains its former vigour and functions, as far as the exerciſe induced and functions injured during the ſeveral ſtages will allow.

"The interval between one fit and the ſucceeding one, will be proportionate to the duration of the habit of reſiſtance acquired. Some perſons thus experience but one fit, and all is over; for, under the ſame circumſtances they are never invaded by a ſecond. Others ſuffer two fits, or a ſucceſſion of fits, and after a while become ſo accuſtomed to the ſtimulus, that, if always applied in the ſame degree of ſtrength, its effect is no longer felt upon the body: in other inſtances again, ſo hard is it for the conſtitution to be moulded into a ſettled habit of oppoſition, that after enduring a great number of invaſions, it becomes at length enervated and worn down ſo much as finally to die exhauſted.

"The ſpecies of fever, whether quotidian, tertian, &c. will depend upon the readineſs or quickneſs wherewith the offending cauſe gains a new aſcendancy over the body, or breaks the habit. And to the mobility of the body, or eaſe with which the habit is broken, is to be aſcribed, as well the frequency of the returns, as the duration and ſeverity of the paroxyſms.

"The anomalous caſes of fever, which have puzzled phyſicians to explain, and noſologiſts to arrange, are thus very naturally accounted for; ſince, according to the variation of the cauſe, as the noxious atmoſphere may thicken or diſperſe, will be the variety in the effect produced; and as there may

be

be infinite gradations of the deleterious cauſe, there may be endleſs varieties in the morbid effect.

" And to this principle of the human conſtitution, I believe, may be referred all the febrile ailments from the moſt trifling intermittent to the more ſerious remittent, and the ſolemn form of continued fever.

" Hence further may it be underſtood how a ſucceſſion of fits, long continued, may diſpoſe the conſtitution to a repetition of fits, even when the morbid cauſe is away: for though there may be a habit of inſenſibility produced to the vitiated airs, yet a habit may, in the mean while, be eſtabliſhed in the bodily motions of falling periodically into regular trains of action, even when the original cauſe is withheld. Here then will be produced a habit of having paroxyſms depending on the particular inward ſtate of the moving fibres, after the manner of temporary ſeaſonings; while, at the ſame time, there is a habit formed of reſiſting the active cauſes (vitiated air) altogether, or of obtaining a permanent ſeaſoning as to them.

" The cold ſtage of a paroxyſm is a ſtate of direct debility, induced by the vitiated air breathed operating to ſubduct heat and oxygen from the body; and its termination is by the ſtimulus of the vitiated air being for that time worn out. The hot ſtage, which begins as ſoon as the temporary ſeaſoning is induced, is a ſtate of excitement brought on by the heat and oxygen now operating upon the accumulated excitability with additional force.—The ſweating ſtage is formed after the ſubſidence of the exceſſive action of the body, and the conſequent enlargement of the diameters of the veſſels, whereby ſweat is formed by the combination of hydrogen and oxygen, and the other ſecretions proceed again, as uſual, in the ſeveral glands.

" The length of interval between the paroxyſms depends upon the ſtrength of habit acquired.

" The frequency of their occurrence will be proportioned

to

to the facility with which a temporary habit is broken or gives way.

"The cold ſtage is the moſt dangerous; and perſons dying in it, die of the direct debility induced by the vitiated atmoſphere they reſpire.

"The hot ſtage is leſs dangerous, and perſons who die in it expire in a ſtate of indirect debility. But, according to circumſtances, death may happen in both the cold and hot ſtages.

"The ſweating ſtage is a mere conſequence of the cooling of the body, after the preceding heat and excitement of it."

Our limits will not permit us to detail, at length, all the arguments that have been brought forward in ſupport of this theory, by its author Profeſſor Mitchill of New York, and by thoſe medical gentlemen in America who have embraced his opinions. We have however endeavoured to give ſuch a conciſe yet accurate account of the theory, and the grounds on which it is ſupported, as may enable thoſe of our medical readers, who have not ſeen the American publications on the ſubject, to form ſome opinion reſpecting it. We give no opinion of our own—that does not belong to our province. It will not however eſcape the notice of medical men, that daily obſervation preſents ſome facts which, on firſt view at leaſt, do not appear reconcileable with this theory. Copper-plate engravers, in the courſe of their buſineſs, are often obliged to breathe an atmoſphere loaded with ſeptic (nitrous) gas, without appearing to be more liable to contagious diſeaſes than other men; and, to mention no other fact of this kind, it has been proved, by the experiments made on board the Union hoſpital ſhip by deſire of the Lords Commiſſioners of the Admiralty, of which we gave an account in our laſt Volume, page 68, that the fumes of the nitric acid are not only a cure, but an antidote againſt contagion. A. T.

XIV. *De-*

XIV. *Deſcription of a Machine for drawing Bolts in and out of Ships. Invented by* CAPT. WILLIAM BOLTON *of the Navy. From* Tranſactions of the Society for the Encouragement of Arts, &c. *Vol. XVI.*

THE gold medal was voted to Captain Bolton for this contrivance, a model of which is preſerved for the uſe of the Public in the Society's repoſitory.

AAAAAA (Plate IV.) is the frame of the machine. B, a cylindrical tube, having a female ſcrew in the inſide. C, a wheel with teeth attached to the cylinder B. D, an endleſs ſcrew adapted to the wheel C. E, handle of the winch. F, the bolt drawing out. GG, blocks to ſupport the frame. H, a hollow piece of ſteel, having on its outſide a male ſcrew, whoſe threads work within the female ſcrew in the cylinder B. To this piece of ſteel the bolt is to be riveted. I, a ſemicircular piece of ſteel, which is to be introduced into the notches on H, when a ſimilar notch has been cut in the head of the copper bolt, which by this means is prevented from turning in H, while drawing. K, the bolt, as prepared to receive the machine. L, a ſteel bar, ſomewhat ſmaller than the bolt to be drawn, having at one end a male ſcrew, A, and at the other end another male ſcrew that fits into the female ſcrew in B. M, a ſection of a male ſcrew, having a ſquare hole larger than the bolt. N, a bolt with a male ſcrew at one end ready to be drawn in.

The machine, of which a plate is annexed, conſiſts of a frame ſupporting a cylindrical female ſcrew tube. On this tube is mounted a wheel with teeth adapted to an endleſs ſcrew fitted to the frame, and worked by a handle.

To draw the Bolt out.

The head of the bolt muſt be cut off, and a hole made in the timber big enough to receive the male ſcrew H, which

is

is put over the bolt: a ſlit is then to be made, either by a ſaw or cold chiſſel, in the head of the bolt, to receive the key I, and which correſponds to the ſlit in H: the bolt head is then to be riveted as firmly as poſſible upon H: the cylindrical tube, B, is then to be ſcrewed on, turning the whole machine round till it can be done no longer, when the endleſs ſcrew is to be uſed. If the machine is of a proper ſtrength, and the riveting well done, the power is ſuch as to extract the bolt or break it, but generally it will be drawn out uninjured.

To draw Bolts into Ships.

It will be neceſſary to have a bar, L, which I recommend to be made of ſteel, long enough to paſs from the inſide to the outſide of the ſhip, and ſomewhat ſmaller than the copper bolt intended to be drawn in. This may be called a conductor. On one end ſhould be a male ſcrew, *a*; the bolt to be drawn in ſhould be tapped at one end to receive the male ſcrew, *a*, on the conductor, and at the other end ſhould be another male ſcrew that fits into the female ſcrew in B; after which the operation is the ſame as drawing a bolt out, and the machine ſhould be applied accordingly. When the bolt arrives at its deſtined place, it may be ſecured on the inſide by a nut, which is as good a way of faſtening as clinching, and much more expeditious.

This machine, though only of the height of eighteen inches, will draw bolts in or out of any length; for, after the bolt has riſen to the top of the tube, it will only be neceſſary to ſcrew the machine back, and follow up the work with blocks of timber, as repreſented in the drawing.

Note. If the upper part of the hole in H be made ſquare, larger than the round hole as ſhewn at M, and the head of the bolt riveted into it, it will do away the neceſſity of the key, I, render the machine leſs complicated, and ſave much time and trouble.

XV. *Description and Use of* C. Guyton's *Eudiometer.* *From* Journal de l'Ecole Polytechnique, *P.* 11.

Chemists and Philosophers have long wished for an eudiometer capable of shewing exactly the quantity of oxygen gas mixed in any other gas. Berthollet has proved, in his Lectures at the Normal School, that the eudiometer of Scheele, which he justly considers as the best, has still great defects, as the absorption requires several hours, and as towards the end there is a decomposition of water, and consequently a disengagement of hydrogen gas, which occasions uncertainty respecting the quantity absorbed.

This induced me to seek for some substance which in a convenient manner might immediately give a more accurate result than nitrous gas, hydrogen gas, phosphorus, and a mixture of sulphur and iron, the only substances which, as far as I know, have been hitherto employed for that purpose.

Sulphure (sulphuret) of potash appeared to me fit to be tried under this point of view. I was well aware that at the ordinary temperature it is susceptible only of a combustion still slower and more insensible than a moistened mixture of sulphur and iron; but I presumed that, if the temperature were raised by applying a small taper, it would be sufficient to put in action the affinity, and to determine rapidly an absorption which would not then be affected by any foreign cause. The effect fully answered my expectation; so that the question then only was to determine the apparatus necessary to form this new eudiometric instrument. I thought that an inversed retort would unite simplicity, convenience, and every advantage that could be desired. The following is a description of it.

A B (Plate V.) is a small glass retort with a long neck, and capable of containing from 12 to 15 centilitres*. One must be chosen so much bent that, when the neck is placed vertically, the bulb may form in its lower part a cavity con-

* About eight cubic inches.

taining

taining the matters introduced into it. The extremity of the neck is ground with emery to fit air-tight at C into the glaſs tube C D, open at both ends, and 20 or 25 centimetres in length. F is a cylindric veſſel—a common glaſs jar, into which the tube of the glaſs C D may be entirely immerſed below the ſurface of the water.

When you wiſh to try any aeriform fluid in order to ſeparate its parts, and diſcover the quantity of reſpirable air it contains, put into the retort two or three bits of ſulphure of potaſh of the ſize of a pea; fill it with water, taking care to incline it to make all the air which might remain in the bulb paſs into the neck; ſtop with the finger the orifice of the retort, and place it in the pneumatic tub, that the gas to be tried may be introduced in the uſual manner. By inclining it again, alternately in different directions, all the water may be eaſily diſplaced, and the ſulphure left remaining in the bulb.

Then place the retort vertically, and introduce the end of it into the glaſs tube C D, which muſt ſtill be under water; and place below the bulb a ſmall lighted taper. To preſerve the retort in its poſition, a cover of wood, with an aperture for its neck to paſs through, ſhould be fitted to the jar.

The firſt impreſſion of the heat dilates the gaſeous fluid, ſo that it deſcends almoſt to the bottom of the tube, which has been diſpoſed on purpoſe to receive it, and to hinder any part of it from eſcaping, which would be the caſe if the tube were not ſufficiently long, and which would prevent the diminution from being accurately determined. As ſoon, however, as the ſulphure begins to boil, the water aſcends with rapidity, not only in the lower tube, but alſo in the neck of the retort, notwithſtanding the application or even augmentation of the heat. If it be vital air abſolutely pure, the abſorption is total. In that caſe, to prevent the veſſel from burſting, which might happen were it cooled too ſuddenly, the aſcent of the water muſt be retarded, either by removing the taper, or inclining the retort, which will not hinder

hinder the abſorption to continue, while there remains gas proper for maintaining combuſtion.

If it be common air or vital air mixed with any other gas, you muſt, after cooling, meaſure the quantity of water which has entered the retort, and which will exactly repreſent the bulk abſorbed. You muſt not neglect to confine the remaining gas under the ſame preſſure, by immerſing the retort in the pneumatic tub, till the internal and external water be on the ſame level, before you cloſe the orifice by a ſtopper. This operation, very eaſy when you have graduated veſſels, may be made in common practice by means of a piece of paper cemented along the neck of the retort, and having traced out on it diviſions determined by experiment, and which may be covered with varniſh to defend it from the action of the water.

C. Chauſſier has conſtructed, for eudiometric experiments by phoſphorus, an apparatus ſomewhat different, compoſed of a long tube all of one piece, one end of which is bent and blown into a bulb, and having, as at *e*, a tubulure ſhut with a ſtopper after the water has been made to aſcend in the inſide of the tube to two-thirds of its height. This inſtrument would ſerve alſo for experiments with the ſulphuret of potaſh; but I muſt obſerve, that the execution of it is not ſo eaſy as on the firſt view might appear. Beſides, if the tubulure renders it very convenient for trying atmoſpheric air, the caſe is not the ſame in regard to other gaſes which cannot be introduced but by tranſmiſſion.

XVI. *On the Component Parts of Iron-ſtones, and how theſe in the manufacturing affect the Quality of Crude Iron. By* Mr. DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

IRON-STONES, though commonly denominated ores of clay, contain notwithſtanding a variety of mixtures, and may with propriety be divided into the following claſſes:

1. Iron-ſtone that has clay for its chief component earth, and this clay comparatively pure and free from ſand.

2. Iron-ſtone poſſeſſing lime for its chief mixture, and this lime alſo comparatively deſtitute of ſand.

3. Iron-ſtone that unites clay and lime, containing large proportions of ſilex; hence, for diſtinction's ſake, may be denominated ſiliceous iron-ſtones. I ſhall therefore, in naming theſe varieties, uſe the following terms as they are arranged in ſucceſſion. Argillaceous, calcareous, and ſiliceous iron-ſtones. None of theſe earths exiſt ſingly with the iron. All iron-ſtones contain a mixture of the three, in various proportions; from which ariſe the ſuppoſed variety of the qualities of crude iron, which each reſpective ſtone is ſaid to contain. There are ſome, however, which are compoſed of nearly the ſame proportions of clay, lime, and ſilex; and theſe commonly afford, when compared with themſelves, a ſimilar quality of crude iron.

Nature, in the formation of theſe ſecondary ores of iron, has invariably impreſſed characters upon them, eaſily to be developed: by which means their qualities, and the conſequent effects produced in the blaſt-furnace, may be accurately and diſtinctly prejudged. The ſource of this information is, the ſtudy of the nature of the united earths; by aſcertaining the quantity and proportion of which, we are enabled to pronounce exactly upon the quality of the iron likely to be obtained from the ore. We muſt not, however, conſider theſe characteriſtic features as a conſequence of the metal exiſting of a variety of qualities; but, *a priori*, we ought to conſider, that, as a conſequence of the nature and proportions of the mixture, the iron will be called into exiſtence in a ſtate more or leſs oxygenated or carbonated.

When iron-ſtones are ſaid to contain *good* or *bad* iron, the expreſſion ought to be underſtood, which by the bye is ſeldom the caſe, only as a comparative aſſertion, confined to local rules, and judged by certain fixed local ſtandards; into the account of which many things muſt be taken, which are frequently overlooked. At every iron-work, a certain proportion

portion of fuel, coaks or wood char, by weight, is underſtood to be ſufficient to ſmelt, and give principle to a determinate weight and quality of iron-ſtones combined together, in order that a certain quality of crude iron may be produced. In this caſe, ſhould a new iron-ſtone be ſubſtituted for one whoſe quality and effects are already known, and ſhould its application be productive of iron leſs carbonated than formerly, it would inſtantly be denominated a *bad* iron-ſtone, or an iron-ſtone containing bad iron—an aſſertion only true comparatively ſo far as it would affect the intereſt of the manufacturer, unleſs corrected by an addition of fuel, a change of the mixtures of ores, or a varied application of the lime-ſtone uſed as a ſolvent or flux. But this is no proof that the quality of iron, as it exiſts in the ore, is bad, ſince a larger proportion of coaks, or a change of mixture, which incurs no additional expence, can correct the evil. It rather furniſhes a demonſtration that the iron in all ores is the ſame; but that, in calling it into a metallic form, the quality is affected chiefly by the reduction of thoſe mixtures originally united with it.

As the quality of the fuel is improved in a direct ratio to the quantity of carbon which the coal contains, and its purity, hence ariſe the great variety of coaks uſed in ſmelting iron-ſtones; ſome of which will ſmelt, and give principle to the iron contained in double the weight of the ſame ores that others will. From this then may be deduced another proof, that *good* and *bad* iron are terms of comparative meaning only, confined to ſituation. Let it be conceived that a change of fuel oppoſite in its quality to that now mentioned was to take place; the ſame quantity of ore, which with the good coaks would have afforded metal richly carbonated, would now yield its produce in a partial degree, and that highly oxygenated—almoſt unfit for any purpoſe. The conſequences here entailed are the ſame, though they may be attributed to different cauſes; the former as derived from the hoſtile mixture of the ore, but the latter as ariſing from a deficiency in the quality of the coaks.

Beſides theſe two leading inſtruments of alteration in the ſmelting proceſs, inherent in and derived from the materials, good and bad effects may be produced from an unjuſt proportion and quality of the lime-ſtone, which is added, in order that the proper equilibrium may be reſtored, and the iron properly and beneficially revived.

Taking this then for a general principle, that the crude iron contained in all iron-ſtones is the ſame, and that it can be called into exiſtence as a metal of all the various degrees of carbonation, by regulating the proportion of fuel, and of the ſolvent; I ſhall proceed to mention thoſe mixtures which I have always obſerved determine the future quality of the crude iron.

1. Argillaceous iron-ſtone having fine clay as its chief component earth, lime in the next proportion, and both theſe nearly deſtitute of ſand; which, when properly torrefied, exhibits fibres on its internal ſurface, of a brown, dark-brown, or claret colour, running either in ſtreaks or radiated, and adhering tenaciouſly to the tongue, will afford, with a moderate proportion of coaks and lime-ſtone, iron of the fineſt quality, poſſeſſing ſtrength conjoined with an intimate degree of fuſibility.

2. Calcareous iron-ſtone, that which contains lime as its principal earthy mixture; holding clay in the next proportion, and both theſe comparatively unallayed (totally they never are) with ſand; which, when regularly torrefied, aſſumes a variety of ſhades generally lighter in the colour than the former claſs; which ſometimes, and ſometimes not, preſents internal fibres, and which adheres leſs tenaciouſly to the tongue; always contains iron, which can be revived, richly carbonated with a comparatively ſmall quantity of coaks, and with a trifling addition of lime. Under this claſs of iron-ſtones are found thoſe which produce iron of a fuſible nature, ſeldom connected with ſtrength, but valuable for its utility in fine caſtings, which require ornament more than durability. It is alſo from this ſource of mixture that I would trace the red ſhort quality of bar-iron. The

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nature impoſed upon crude iron in the blaſt-furnace by the development of its mixtures, moſt commonly accompanies it through all its ſubſequent ſtages of exiſtence as a metal.

3. Thoſe iron-ſtones whoſe component parts are nearly an equaliſed mixture of clay, lime and ſand, which torrefy with a ſlight degree of adheſion to the tongue, aſſuming a dark-red or browniſh colour, void of internal fibre, always afford, with the local proportion of fuel, iron of an intermediate quality for fuſibility and ſoftneſs, but generally poſſeſſing ſtrength in an eminent degree. Such iron is excellently adapted for the manufacture of great guns, mortars, and the large ſpecies of machinery. Its application to the purpoſe of bar-iron making, would alſo be attended with the moſt beneficial effects, poſſeſſing neither the extreme of fuſibility nor of infuſibility: it would greatly prevent, in the manufacturing, a tendency, which iron poſſeſſed of theſe extremes has, to become red or cold ſhort.

4. Iron-ſtones which unite a large proportion of ſand with ſparing proportions of clay and lime, which, upon being ſlightly expoſed to heat, exhibit maſſes of ſemivitrification, neither obedient to the magnet, nor adheſive to the tongue, having a refractory diſpoſition to part, and poſſeſſing a dark-blue or black colour, always afford, with the uſual proportion of fuel, crude iron of the worſt quality, either as to ſtrength or fuſibility. Such metal is commonly highly oxyginated, and brittle; incapable of being uſed alone for any melting purpoſe; and, when applied to the uſe of the forge, affords malleable iron, which poſſeſſes the cold ſhort quality.

Theſe are the four principal claſſes under which I have arranged our iron-ſtones, with regard to their tendency to afford their iron carbonated, poſſeſſing ſtrength, or otherwiſe, when ſmelted in the blaſt-furnace with a determinate quantity of fuel. As this claſſification is exactly analogous to the reſults obtained in the large way, it may ſerve as a ground-

work to thoſe who may wiſh to attain a practical knowledge of theſe ores, ſo far as it relates to their manufacture.

It is however eaſy to counteract the natural tendency which every iron-ſtone has in this caſe, to afford its iron of a certain quality, and to make each of them yield crude iron of all the different degrees of fuſibility and ſtrength. Is it not obvious, that ſince the qualities of crude iron depend upon the mixtures and their kinds compoſing the ſtones, that if nature be aſſiſted by adding or ſubtracting from them in the blaſt-furnace, every quality of crude iron may be produced from the ſame iron-ſtone? I have ſeen moſt of theſe reſults determined in the large way, and the whole of them beautifully confirmed in the aſſay-furnace.

It remains with the preſent manufacturer to conſider whether it will be more his intereſt to reject ſuch iron-ſtones as are of difficult carbonation, or to apply the neceſſary additional proportions of fuel, capable of correcting the quality of ſiliceous iron-ſtones. Not ſo, however, to thoſe who may at ſome future period ſucceed him; neceſſity, at all times ingenious, aſſiſted by the increaſing light which ſcience daily ſheds over our manufactures, will deviſe the means of calling into profitable exiſtence the metal contained in all thoſe ores which may have fallen into diſrepute in the preſent day, or from which at this time it is thought impracticable to extract metal in the large way.

The uſual criterions by which iron-ſtone is judged, whether it be ſufficiently rich in iron for the purpoſe of ſmelting, are the following:

1. The degree of tenacity with which it adheres to the tongue after torrefaction: 2. Its colour: 3. The obedience to the magnet when pulveriſed: 4. By depriving of its iron a given weight of the ore, in contact with charcoal and fuſible earths in the aſſay-furnace.

The firſt and third of theſe methods are liable to great error. The adheſion to the tongue will be more in proportion

tion to the quantity of clay and its kind contained in the ſtone, than to its real contents in iron. Iron-ſtone may alſo be torrefied in ſuch a manner as to deprive its internal ſurface of this property; as it is only peculiar to the ſtone at a certain ſtage of torrefaction.

The influence which the magnet poſſeſſes over ſome ores of iron is no direct proof of the quantity of iron contained; as ſome ores which contain 15 parts in 100 are completely magnetic, while others again that contain 60 to 70 parts of iron in 100 are not in the ſmalleſt degree affected with this property. The magnetic teſt is more uſed to aſcertain the exiſtent ſtate of the metal, whether mineraliſed with an acid, combined with ſulphur or with oxygen, or exiſting in a diſengaged ſtate more or leſs metallic. No iron-ſtones which in their native ſtate contain their iron mineraliſed with oxygen, or in the ſtate of an oxyde, completely diſperſed through an intimate combination of clay, lime and ſilex, containing water, carbonic acid, and ſometimes concrete ſulphur, are obedient to the magnet till ſuch time as torrefaction has paſſed upon them, either expoſed to open air, or in contact with charcoal in cloſe veſſels. If this proceſs is continued for a ſhort time, the whole maſs will become obedient; but this affection will ſtill depend upon the relative quantity of concrete oxygen fixed with the iron. Individually, however, iron-ſtones are affected by the proportion of heat conveyed to them while torrefying. If the quantity communicated has been ſparing, ſo as not to have carried off all the water, carbonic acid, &c. the magnetic virtue will alſo be proportionally abſent: if the diſſipation of theſe ſubſtances has been complete, the magnet will poſſeſs an influence in the exact ratio of the quantity of oxygen which remains combined with the metal. Should it happen that a degree of heat capable of exciting fuſion is applied, the maſs will then rapidly loſe its magnetic obedience by an extra-fixation of oxygen; if driven ſo far as to make it exhibit a ſemi-vitri-

fied appearance, this principle would be found to be entirely annihilated.

Although the colour which iron-ſtones aſſume in torrefying intimately depends upon the degree of heat preſented to them in the operation of burning, yet, by regulating this agent in a proper manner, an accurate knowledge may be formed, not only of the probable quantity of iron, but even of its tendency to become carbonated in ſmelting. The expulſion of the water and acid leaves the combined earths more expoſed to determination. The ſmall ſpecula of ſilex are diſtinctly diſcerned; adheſion to the tongue develops the preſence of clay; and lime is indicated by its aſſuming a whitiſh colour, either ſtriated, or diſſeminated, approaching towards the ſurface of the ſtone.

The laſt method mentioned, namely, that of depriving a given portion of ore of its iron, is the moſt conſonant to truth and to the ideas of the manufacturer. Acids may be uſed as a check upon the aſſay by fuſion; but this intricate, or rather this ſlow proceſs is chiefly reſorted to by chemiſts, and ſeldom goes beyond the bounds of the laboratory. In aſſaying by fuſion, not only the quantity of iron may with preciſion be aſcertained, but alſo the quality of crude-iron likely to be produced from the ore, with the local proportions of fuel in the large way. The earths formerly united with the iron, now become fuſed with thoſe added for ſolvents. Theſe float upon the ſurface of the extracted metal, and, when cold, may afford information, from their colour and tranſparency, concerning the regulation of future proportions upon a more extended ſcale. This ſubject I ſhall more minutely illuſtrate in a ſubſequent paper on the aſſaying of iron-ores by fuſion.

The burning or torrefying of iron-ſtones, known in the large way by the rather improper term of *calcination*, conſiſts in expoſing the ſtone to a certain degree of heat in contact with air, in order to diſpel thoſe ſubſtances which it

contains,

contains, capable of aſſuming the aëriform ſtate by the combination of caloric. This operation ought to be performed in a progreſſive heat, always ſhort of fuſion. The water is then ſlowly evaporated without being decompoſed; the caloric unites to the carbonic acid, which ſoon aſſumes the gaſeous ſtate; and laſtly, the ſulphur, if any, ſublimates.

This proceſs is eſſentially neceſſary to be performed before the iron-ſtone is introduced into the blaſt-furnace. Were raw iron-ſtone, or ore, precipitated in the violent heat of the ſmelting-furnace, the water and acid would inſtantly be decompoſed; the oxygen would partly unite to the iron in addition to the fixed quantity peculiar to each ore, and part of it would oxygenate the ſulphur, either of the ore, or of the pit-coal, a portion of which is always preſent in the furnace. The whole maſs would then be precipitated in fuſion, and a dark porous lava obtained, containing iron more difficult to be revived than ever, owing to the great quantity of oxygen combined with it. In caſes of this kind, the diſengaged hydrogen manifeſts its eſcape, by changing the colour of the flame from a mellow white to a pale ſickly blue.

It muſt from all this appear obvious, that, when torrefaction has been properly conducted, a very conſiderable part by weight of the whole will be diſſipated: the abſence of theſe volatile ſubſtances always leaves the iron-ſtones more or leſs magnetic. The loſs of weight, however, is very different in the various claſſes of iron-ſtones, even when they are all expoſed for the ſame length of time to a degree of heat capable of expelling thoſe mixtures, which, under ſuch circumſtances, aſſume the gaſeous ſtate.

1. Calcareous iron-ſtone, when properly expoſed to torrefaction, loſes more of its weight than either of the other two claſſes. Where the lime is abundant, I have found this iron-ſtone loſe 38 per cent. but more commonly 35 and 36 per cent. of water, carbonic acid, and ſulphur.

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2. Argillaceous iron-ſtones, expoſed to a ſimilar degree of heat, and treated in the ſame manner, commonly loſe in weight from 32 to 35 per cent.

3. Siliceous iron-ſtones always give out leſs weight when expoſed to torrefaction under ſimilar circumſtances with other ſtones. In common they loſe from 27 to 30 per cent. I have, though rarely, found them to give out 25 per cent. only.

The extreme loſs of weight in each claſs muſt be conſidered as the utmoſt point to which torrefaction can with ſafety be urged, without expoſing the iron-ſtone to an accumulation of weight by the combination of oxygen.

From the variouſly compounded natures of iron-ſtones ariſe the various calculations of the loſs which they are ſaid to ſuſtain in burning, at different iron-works. Fields of iron-ſtone are commonly impreſſed with a general diſtinguiſhing characteriſtic feature: ſome are of the calcareous genus; ſome of the argillaceous; and others again have a more intimate alliance with ſilex than the former two. Hence we find, at thoſe works where the chief ſupply is drawn from the argillaceous iron-ſtones, that the loſs in torrefaction on the great ſcale is computed from 30 to 33 per cent. Where calcareous iron-ſtones form the chief ſupply, the loſs is eſtimated at from 35 to 37½ per cent. Few or no iron-works are obliged to have recourſe to iron-ſtones abounding with ſand for their chief conſumption: a general eſtimation of the loſs ſuſtained by this ſtone in the large way is therefore difficult to be made, though, I have heard, that at ſome works 25 per cent. was all that was allowed to be expelled during burning. Nature has been extremely kind in the formation of our ſecondary ores of iron; as the bulk of them, that contain iron ſufficient to entitle them to be ſmelted, are combined with ſuperior proportions of clay and lime.

As the burning or torrefying of iron-ſtones is of great importance

portance to the manufacturer, and as it may be in ſome reſpects gratifying to the man of ſcience, I ſhall particularly enter into the various phenomena attending the operation; dividing torrefaction into two claſſes: that which deprives iron-ſtones of certain ſubſtances capable of becoming aëriform by the combination of caloric in contact with atmoſpheric air; and that which deprives ores of their oxygen—hence called de-oxygenation—by heating them in contact with charcoal, in cloſed veſſels, or in cavities impervious to the external air.

1. The conſequences of heating iron-ſtone expoſed to air is a loſs of water, ſulphur, and carbonic acid*. A ſmall portion of oxygen may at times be unfixed, when the fuel may chance to come into contact with the heated iron-ſtone under a partial excluſion from air. But the aſſociation of circumſtances neceſſary to effect this can ſo ſeldom be the effect of chance, that it is never to be looked for with certainty. When the operation is properly performed, the laſt particle of acid and water may be expelled. But this point is difficult to be aſcertained with any degree of exactitude: for, in proportion as theſe gaſeous ſubſtances are carried off, the metal becomes more and more revived, of courſe more and more liable to attract, and fix oxygen by the decompo-

* I have ſeen ſome iron-ſtones in torrefying depoſit a beautiful oxyde upon their ſurface, of a lake colour, and light as down. The ſame ſubſtance, I have obſerved, effloreſced upon the ſurface of the fracture of highly oxygenated crude iron, which had been broken immediately after the metal had loſt its fluidity. From this coincidence of effect, I am inclined to ſuppoſe, that the oxyde depoſited on the iron-ſtone in burning is the conſequence of the decompoſition of the ſulphuric acid; a portion of which had been mineraliſed with the ſtone, holding iron in ſolution: and that in the latter it was occaſioned by a ſuperabundance of oxygen in the blaſt-furnace, probably from the introduction of raw iron-ſtone, which had eſcaped the effects of the fire: that the ſulphur, as formerly ſtated, had become oxygenated, diſſolving a portion of the metal; which was again depoſited in the ſtate of a calcined ſulphat, when the acid was ſuffered to eſcape, by being freely expoſed at a high degree of heat to open air.

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ſition of the ignited gas; and, as the laſt portions of the acid and water are diſtilling, the ſtone is apt to gain weight by the calcination (oxygenation) of its iron. This will poſitively be the caſe when the heat is carried beyond the neceſſary degree, and is indicated by the iron-ſtone ſwelling in bulk, becoming ſpecifically lighter and porous on the ſurface, but gaining weight in a great degree internally. As oxygenation goes on, the magnetic virtue decreaſes, until at laſt it becomes entirely annihilated.

The firſt ſtage in torrefaction is indicated by the firſt general change of colour in the iron-ſtone. This is commonly a faded blood colour, more or leſs dark according to the quantity of lime preſent.

I have repeatedly made uſe of all the various iron-ſtones, in the ſtate of a fine powder, in order to aſcertain what was the weight loſt by each claſs in its tranſition from its native hue to the firſt ſtage of an aſſumed colour. And I am enabled to ſtate the following as an average of the reſults obtained on this head: Calcareous iron-ſtones give out 6 parts in 100 of the raw mineral; argillaceous iron-ſtones, 5; and ſiliceous iron-ſtones, $4\frac{1}{2}$.

If the pulveriſed iron-ſtone is thrown into a veſſel red hot, this loſs will be effected in two minutes. The change of colour is immediately effected on thoſe parts in contact with the heated iron. The whole is brought into contact with it; and when thrown out, the magnet will be found to have acquired a perceptible influence over it. When the powder is firſt thrown in, a ſlight decrepitating noiſe is heard for a few ſeconds. This operation may alſo ſerve to ſhew the preſence of ſulphur, or of its acid. When in the former ſtate it inſtantly takes fire, and burns with a dark lambent flame. When the acid is preſent, it is eaſily known by the ſuffocating fumes diſengaged by the action of heat.

The application of heat beyond the firſt ſtage of colour, cauſes the iron-ſtone to paſs through a variety of ſhades. Theſe,

Theſe, as in metallic ſubſtances, are the effects of the preſence of air at certain degrees of heat*. As the progreſſive diſſipation of the volatile mixtures takes effect, the colour deepens; and, according to the nature of the iron-ſtone, becomes fixed, of a brown, dark brown, or deep claret colour. Theſe indicate the almoſt entire expulſion of the water, acid, &c. In this ſtate all iron-ſtones are poſſeſſed of magnetic attraction, and exhibit the various phenomena already deſcribed, as being peculiar to their reſpective natures.

The methods commonly in uſe for torrefying iron-ſtone, in the large way, are of two different kinds: that of burning in kilns or conical furnaces; and that of expoſing iron-ſtone in open air, ſtratified with coals, to combuſtion. The former is uſed in ſome places in Wales; the latter is almoſt univerſally adopted in England, and totally ſo in Scotland.

In the operation with furnaces, they become filled entirely with iron-ſtone, except a ſtratum of coals in the bottom, which is afterwards inflamed. The combuſtion is then carried on by means of a current of air paſſing through the furnace, and forcing the heat along with it. When the iron-ſtone is deemed ſufficiently burnt, the regiſter is ſhut up; and the combuſtion, no longer maintained by means of external air, ſoon dies away, and leaves the furnace to cool.

The moſt common method, however, of burning iron-ſtones, conſiſts in levelling a piece of ground, and covering it with a layer of ſmall pit-coals. This is of various thickneſſes, 4, 6 or 8 inches, according to the height the pile is to be built, and the nature of the iron-ſtone. Upon this ſtratum of coals the pieces of iron-ſtone are imbedded, as near to the ſame ſize as poſſible, in order that all may be equally acted upon. Theſe are reared to various heights,

* From ſmooth-ſurfaced iron-ſtones and ores, when expoſed to heat partially ſheltered by charcoal duſt from the action of air, I have obtained all the ſhades of colour peculiar to poliſhed iron and ſteel; but with leſs of the metallic luſtre, owing to the ſurface being more porous.

18, 20 to 24 inches, the determination of its height depending upon circumſtances. The ſurface is a ſecond time levelled, by introducing ſmall pieces of iron-ſtone betwixt the interſtices occaſioned by the angles of the larger. This again receives a covering of ſmall coals, ſeldom exceeding 2 inches in thickneſs. Upon this is reared the ſubſequent building, always gradually narrowing itſelf till it has aſſumed the ſhape of a ſtout wedge, with its baſe reſting upon the ground. After this is effected, the whole of the external ſurface receives a complete covering of the ſmalleſt ſort of coals. The pile is kindled by applying burning coals to the ground ſtratum. This creeps ſlowly along; heats the ſtone upwards; kindles the ſecond layer of ſmall coals, and ultimately inflames the whole maſs from top to bottom.

When the coals are conſumed, the pile gradually cools, and in 8 or 10 days may be wheeled away to the furnace.

The quantity of iron-ſtone burnt at one time is various at different and even at the ſame places; ſome kinds require to be burnt in ſmaller heaps, owing to their nature and fuſibility. At ſome works the fires extend from 50 to 60 yards; and it is not uncommon to ſee ſkilful workmen, at one end, adding freſh materials to the burning pile; while others, at the oppoſite end, are employed wheeling away that which the fire has left ſufficiently burned for the purpoſe of the furnace. Fires that extend from 30 to 60 feet in length are more common; from 10 to 16 feet wide, and about 5 feet high.

At moſt iron-works a local opinion exiſts, to what degree of heat iron-ſtone ought to be expoſed before it is properly fit for the blaſt-furnace. All, however, agree that burning is neceſſary; though few give an accurate reaſon why. The only one I have heard adduced is, that iron-ſtone is *calcined* in order to burn out the ſulphur and other *heterogeneous* mixtures. Hence ariſe a diverſity of opinions, chiefly founded upon individual notions of the fixity or volatility of ſulphur,

ſulphur. Some contend that ſulphur is eaſily diſplaced, and that therefore the iron-ſtone ſhould be moderately *calcined*; leſt the ſulphur from the coal uſed in burning it ſhould enter, and again hurt the quality of the iron. On the other hand, it is ſaid that ſulphur is of difficult expulſion from the centre of the ſtone, as it is never ſeen going off till a bright red heat forcibly expels it; and therefore it is highly requiſite the iron-ſtone ſhould be long and violently expoſed till the laſt portion is got rid of. To effect this, therefore, the heat, ſay they, ought to be urged till ſuch time as the ſtone has indicated ſigns of fuſion, or has partially ſuffered thereby. In order to give ſtrength to this opinion, thoſe who adopt it add, that, by ſuch ſevere *calcination*, the volume of ſtone is reduced, becomes heavier, and that it will conſequently occupy leſs room in the blaſt-furnace; of courſe it is imagined that, bulk for bulk, the iron-ſtone becomes richer in iron than when in a raw ſtate.

Thoſe who are acquainted with the oxydation of metals, and the conſequent increaſe of weight, will at once diſcover the ſource of this error, and readily conceive, that, after the metal in the iron-ſtone has become partially diſengaged by the expulſion of water, carbon acid, ſulphur, &c. forming frequently a third part of the whole weight, it will become an object of attack to the oxygen of the atmoſpheric air; the combination of which with the iron alone adds to the actual increaſe of weight, and not the tranſpoſition of the particles of metal from one piece of iron-ſtone to another. It muſt alſo be obvious that, where ſuch fallacious prejudices have taken root, the conſequences muſt frequently be fatal to the intereſts of the manufacturer; as ſuch iron-ſtones, literally calcined, muſt require an additional portion of fuel to furniſh carbon to carry off the ſuperadded oxygen.

It is ſomewhat remarkable that the phenomena attending the oxydation of iron ſhould be entirely unknown at iron manufactories. Such a proceſs is never dreamt of, and even the declaimers againſt ſevere torrefaction only account for

for the increaſe of weight, by aſſerting that the earthy parts are burnt out and nearly conſumed, and that the metallic parts only remain, deſtroyed however in their nature and *reduced to a cinder*.

We are not to wonder, therefore, at the uncertain reſults which the untutored manufacturer obtains, until ſuch time as a long courſe of experience has taught him, that, by combining certain cauſes, good or bad effects are the conſequence. Even at laſt he ſtill reſts upon an unſtable baſis: deſtitute of the correct operation of principle, and incapable of preventing an evil from a total ignorance of its real ſource of action, he can only in the end avoid it after a multiplicity of movements, wherein he finds his practical knowledge increaſed at the expence of a conſiderable ſacrifice of property.

How much more enlightened would be the mind of the manufacturer, were he to attend minutely to the phenomena developed in all the ſtages of his proceſs, and ſatisfy himſelf as to the radical principles of action in each individual ſtage! In doing this, chemical minuteneſs, the terror and butt of the unphiloſophiſed mind, is not abſolutely indiſpenſible; and yet every thing may be aſcertained neceſſary to be known for the production of certain determinate qualities of crude iron.

He would then eaſily comprehend that all iron-ſtones contain leſs or more water of cryſtalliſation, and that, being combined with a certain proportion of lime neutraliſed with carbonic acid, it is neceſſary that they be expoſed to a heat ſufficient to expel the firſt and laſt of theſe as well as ſulphur. The reaſon has already been given, and the conſequence ſhall be once more ſtated. The evil effects produced by introducing raw iron-ſtones into the blaſt-furnace, are leſs owing to the ſmall portion of ſulphur contained in moſt of them, eſpecially in balls, (the vapours of which ariſe even from the ſofteſt crude iron when fluid,) than to the decompoſition of water and acids, each of which gives up a pro-

a proportion of oxygen to the metal, chiefly before ſeparation is effected.

Does it not then unqueſtionably follow, that if the quantity of charcoal in the furnace formerly was ſufficient to take up the oxygen exiſting in the ore, and to afford carbonated crude-iron, that if a further quantity of this principle is added, by whatever means, part of the charcoal which formerly went to carbonate the iron now combines with the ſuperadded oxygen to form carbonic acid; of courſe the metal will be deprived of its carbon, become white in the fracture, and may then juſtly be denominated oxygenated crude-iron. The ſame application to principle would alſo inform the merely practical man, that when iron-ſtone is completely deprived of thoſe ſubſtances which aſſume the gaſeous ſtate by the combination of caloric at a moderate temperature, it is then ſufficiently prepared for the furnace. This is always indicated by the colour which the ſtone aſſumes varying from a brown to a dark claret. Blues always ſucceed this ſhade; and the ſmalleſt appearance of blue, however light, is a certain ſign that the external air has made an impreſſion upon the particles of metal, by ſuperoxygenating them. Inſtead therefore of expelling a further quantity of *heterogeneous* matter, a principle is added the moſt noxious and deſtructive to the exiſtence of iron in a metallic form.

The phenomenon of iron-ſtone becoming heavier in the fire, would no longer be explained by aſſuming vague aſſertions incompatible with and inadmiſſible to common ſenſe. Upon finding two pieces of iron-ſtone in the ſame fire, which have to appearance been affected in a widely different manner by the heat; the one heavy, of a black blueiſh colour; the other light and porous: the practical man would now no longer ſay that the metal from the porous piece had eſcaped by theſe pores, and entered into the ponderous one; and that the accumulation of weight in the latter was entirely owing to it abſtracting the metal

from the former. Widely different indeed would be the concluſion. He now would have learned that metals are combuſtible bodies; that under certain circumſtances iron is one of the moſt inflammable in the group; that, during its combuſtion, it decompoſes the air that maintains the combuſtion, and fixes one of its elements in ſpite of the powerful affinity exerted upon it by the caloric; and that by this proceſs alone it increaſes its volume and weight. The porous maſs of iron-ſtone would now be deſcribed as having had its iron completely ſaturated with oxygen at a very high temperature; that an imperfect ſtate of fuſion had been the conſequence; and that a combination of theſe circumſtances, acting for a conſiderable length of time, had volatiliſed and carried off a very conſiderable portion of the metal.

On the ſame principle would be explained the increaſe of weight in the more ponderous piece; it would then readily be conceived, that the ſame aſſociation of circumſtances had not been preſent; but that the iron had gained in weight by the addition of oxygen at a temperature ſhort of fuſing and volatiliſing the oxyd.

What I have further to ſtate on this ſubject ſhall be forwarded for the next Number of the Philoſophical Magazine. In the mean time I ſhall ſubjoin a few remarks which may be conſidered in the light of a

Poſtſcript to the Paper on the Principles of Iron and Steel.

In that paper (Phil. Mag. Vol. II. p. 165) I ſtated that the carbon which exiſts in ſteel is in an elaſtic or aëriform ſtate. In a long ſeries of experiments which I made on the diſſolution of crude-iron and ſteel in various acids and in water, I always obtained carbon from the former in a crude concrete form; but the carbon in ſteel always eluded my ſearch, and never appeared till ſome days afterwards, in the manner of a greaſy pellicle, thin and tranſparent upon the

the surface of the fluids. This circumstance confirmed what had long been evident to me, from a knowledge of the principles and the mode of conveying them in manufacturing both these states of iron, that the carbon in crude iron and that in steel existed in a widely different mode of union. And as in the latter it existed not in a crude state, I was led to conclude that an aëriform chemical union was effected, during the process of cementing the steel, by the agency of the caloric on the charcoal, which stratifies the bars during the operation.

In my correspondence, however, with the Editor of the Philosophical Magazine, he threw out some hints that a different kind of chemical union might be effected by the same agency, and that in steel the carbon might exist in a concrete state, though not crude—neutral, though not aëriform. This combination, which I had overlooked, (*humanum est errare!*) appeared so highly probable that I resumed my experiments; and I am happy in now stating that this idea was just, as I have since obtained from steel carbon in the state of an impalpable powder, by the following simple operation.

I introduced into a glass vessel a plate of polished steel, and poured upon it as much clear rain water as covered it three inches. In this state it remained for 50 days, during which time I carefully observed the agency of the water upon the metal. Twenty-four hours after introduction, minute flakes were observed floating lightly in the water; they increased on the second and third days, and fell gradually towards the bottom. As these accumulated, the surface of the water became covered with the same carbonaceous pellicle mentioned above *, exactly resembling the coloured film which is frequently found floating upon the surface of springs where iron is precipitated from the carbonic acid.

* A plate of pure malleable iron underwent a similar immersion in a separate vessel, but exhibited no disengagement of carbon in this state.

During the immerſion of the ſteel, a double affinity was exerted; part of the oxygen of the decompoſed water united to the carbon to form carbonic acid: this union was at any time highly facilitated by raiſing the temperature of the water. The precipitate and oxyd upon the ſurface of the plate then became covered with tranſparent bubbles, which remained if the temperature was decreaſed; but on the contrary roſe to the top and eſcaped, if the heat was augmented. The other affinity excited was that of the oxygen upon the iron; which it ſlowly oxydated, covering the ſurface at firſt with a ſlight yellow membrane of the thickneſs of gold leaf. This daily increaſed, and at the end of fifty days had acquired firmneſs and conſiſtency. After carefully drying the plate, I began to ſeparate the oxyd from the ſurface. This eaſily parted in ſcales, and under it I found the ſurface of the plate entirely covered with fine carbon, without greaſe or the ſmalleſt aſperity. When ſtrewed in the fire, it ſparkled and exhibited the ſame characters as charcoal.

This experiment proves clearly that carbon exiſts in ſteel in a concrete ſtate, though not crude—in chemical union, however, and not as a mere mixture as in crude iron.

I cannot conclude this note without ————————*, and expreſſing a hope that the confirmation of this fact may lead to a ſolution of many of the phenomena attending the manufacture of iron.

* The author here pays us a compliment to which we have no claim, and having already inſerted enough of what reſpects ourſelves to ſhew that we would not willingly diſobey his commands, we hope he will excuſe this ſmall chaſm. EDIT.

XVII. *A remarkable Caſe of internal Pain in the Heel, and an incipient Mortification, cured by the Inhalation of Vital Air: being the Third Communication from* Dr. THORNTON, *Phyſician to the General Diſpenſary, and Lecturer on Medical Botany at Guy's Hoſpital, relative to Pneumatic Medicine.*

MRS. FRITH, æt. 45, wife of the Rev. William Frith, rector of Kentiſh Town, for nearly four years experienced the moſt violent pain in the neighbourhood of the heel, which ſhe could compare to nothing but the burning of a cauſtic. Various outward applications had been made, and medicines taken internally, without any alleviation. When Mr. Cruikſhank, lecturer on anatomy in the ſchool of Dr. Hunter, called me into conſultation, there was extended over the heel a wound about the ſize of a crown, very dark, the edges livid; and the fœtor from it was ſo intolerable that, when her maid had occaſion to remove the dreſſings, ſhe had always volatiles applied to the noſtrils to prevent her from fainting. The countenance ſhewed a livid paleneſs, the pulſe was quick and tremulous, and the ſlighteſt exertion produced faintings. The bark, opium, and wine, were continued. This lady inhaled alſo ſix quarts vital air mixed with twelve of atmoſpheric, and in a few days, as this reſpectable family can alſo teſtify, the livid hue of the wound diſappeared, it had a more healthy appearance, and the diſcharge was ſo greatly improved, and fœtor gone, that when the ſmelling-bottle was preſented to the ſervant, ſhe ſaid that there was not the leaſt occaſion for it. In a fortnight the ſore was completely healed, the appetite reſtored, and countenance ſo greatly improved that every friend marked the ſudden alteration; the violence of the internal pain leſſened by degrees, and the ſuperoxygenated air being continued for a few weeks longer, it altogether ſubſided; and this lady for theſe laſt ſix months has enjoyed

uninterrupted health, and is able, at pleaſure, to walk up Highgate-hill.

As many perſons might wiſh to ſee the lady's journal in her own words, I here ſubjoin it, with a few obſervations.

"September 13. 1798. Firſt inhaled the vital air. Felt acute ſpaſms in the cheſt, and fainted."

Obſervation. Artificial inhalation is accompanied with increaſed action of the intercoſtal muſcles, and gives frequently afterwards a ſenſation of muſcular pain, which ſpeedily goes off, and after a few trials does not appear again. The ſecond effect we always ſee in thoſe very weak, and hence the expreſſion of "*being overpowered by the air.*" Patients labouring under ſcurvy, if ſuddenly expoſed to a clear air, are killed inſtantaneouſly.

"September 15. Felt a moſt pleaſant glow after the inhalation of the vital air. Spirits alſo much increaſed, feeling as if a great weight, or oppreſſion, was removed.

"September 16. The hardneſs about the heel gone, as alſo the fœtor. Has leſs diſcharge. The wound looks redder. The glow after the inhalation of the vital air laſts for about a quarter of an hour.

"September 18. The glow, and ſpirits, after the laſt inhalation, laſted four hours. Feel wonderfully light, and pleaſant.

"September 20. Aſked by my apothecary, 'Whether I did not feel, from the inhalation of the vital air, an *uncomfortable heat?*' My anſwer was, that it produced the moſt pleaſant glow imaginable. not at all reſembling *heat.*"

Obſervation. Putting the thermometer under the tongue, the ſenſible heat was not increaſed. This effect may perhaps be accounted for from the increaſed ſenſibility of the nerves; or, does the inſenſible perſpiration raiſed by the capillaries of the ſkin being filled by the greater energy of the heart, account for this phenomenon better? I have almoſt invariably found the inſide of the palm of the hand, after,

and

and during the inhalation, break out in a pleaſant moiſture, which are parts ſomewhat remote from the heart.

"October 4. The pain in the heel infinitely more lively. The pain is a *new pain*; but, thanks be to God! it remits for three or four hours every day."

Theſe are the chief particulars: the nature of your Magazine may not admit of a further detail, nor does the nature of the caſe ſeem to require it.

General Obſervation. The change of colour in the wound; ſo immediately after the inhalation of the vital air, ſeems to indicate a remarkable change wrought in the blood. It is not, however, the temporary increaſe of oxygen only in the ſyſtem, that this partial inhalation produces; for it renders the blood alſo more attractive of this principle. Hence the continuance for ſome time, even in London, among people of faſhion, of the good looks acquired in the country; hence the pallid countenance of the man lately recovered from ſuffocation, or drowning; and hence alſo the return of the breath in patients under this treatment being more and more noxious, from a greater abſorption of oxygen. The deterioration of the air inſpired, has ever indicated the attractive power of the blood. Hence alſo it is that ſubſtances abounding in hydrogen are called cordials, from their ſympathetic action on the heart, through the medium of the blood: but in the ſuperoxygenated air we have a more direct action on the heart, without exhauſting the irritable principle, and occaſioning indirect debility; and I truſt I ſhall be able to make it evident to the unprejudiced mind, that this is a great deſideratum in ſurgery and medicine, more eſpecially where diſeaſes are remote from the heart; or elſe, why do we ſo frequently hear of *ſore legs*, but never of *ſore arms?* But, however the *modus operandi* of theſe new powers may be, the obſervance of *facts* is of greater importance; and I here beg leave publicly to thank thoſe ingenious medical gentlemen who have honoured me with their correſpondence on this ſubject, the reſult of which will be laid before the philoſophic world.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

ROYAL SOCIETY OF LONDON.

AT the meeting of this learned body on the 21ſt of February, a work of great utility to aſtronomers was read—Dr. Herſchel's 4th catalogue of the fixed ſtars, with their comparative brightneſs.

On the 28th of February a meteorological paper by Mr. Hutchinſon was read; and a curious paper on the ſubmerged foreſts on the coaſt of Lincolnſhire, endeavouring to aſcertain the epoch of the phenomenon, and containing geological obſervations on the different ſtates in which trees are found in the earth, by Mr. Joſeph Serra de Correa.

The meetings of March 7th and 14th were occupied in reading a curious paper on hermaphrodites; which contains alſo an account of ſome ſingular experiments on human generation, ſimilar to thoſe made by Spalanzani on the canine ſpecies.

INSTITUTION

For diffuſing the Knowledge, and facilitating the general Introduction of uſeful Mechanical Inventions and Improvements; and for teaching, by Courſes of Philoſophical Lectures and Experiments, the Application of Science to the common Purpoſes of Life.

OUR readers will be happy to learn that a new Inſtitution under the above title, which promiſes to be of great public utility, has been ſet on foot in this capital, and is expected ſhortly to be eſtabliſhed by Royal charter. The Right Hon. Sir Joſeph Banks, who has ſo long, and with ſo much

honour

honour to himſelf, preſided over the Royal Society, and whoſe ardour in purſuing whatever objects may tend to promote the intereſts of ſcience can only be equalled by his liberality in devoting to their advancement a large portion of a princely income, has given every aid, by his own perſonal exertions and his extenſive influence, to give effect to the plan of this Inſtitution, which was projected by Count Rumford, the ſtrenuous advocate for the application of ſcience to the common purpoſes of life.

We ſhall give ſuch a ſketch of the plan as our limits will allow, extracted from Count Rumford's original propoſals for forming the Inſtitution, which may be had (Price 6d.) of Meſſrs. Cadell and Davies.

The two great objects of the Inſtitution are, the ſpeedy and general diffuſion of the knowledge of all new and uſeful improvements, in whatever quarter of the world they may originate; and, teaching the application of ſcientific diſcoveries to the improvement of arts and manufactures in this country, and to the increaſe of domeſtic comfort and convenience.

Rooms will be prepared for the reception and public exhibition of all new and mechanical inventions and improvements worthy of notice; eſpecially of all ſuch as tend to increaſe the conveniences and comforts of life, to promote domeſtic economy, to improve taſte, or to promote uſeful induſtry.

Perfect models, of the full ſize, will be exhibited in this public repoſitory, of all ſuch new mechanical inventions and improvements as are applicable to the common purpoſes of life. Under this head is included: Cottage fire-places, and kitchen utenſils for cottagers; a complete kitchen for a farm-houſe, with all the neceſſary utenſils; a complete kitchen, with kitchen utenſils, for the family of a gentleman of fortune; a complete laundry for a gentleman's family, or for a public hoſpital; ſeveral of the moſt approved ſtoves for heating rooms and paſſages.

The

The machinery exhibited will, as far as poſſible, be ſhewn in action, or in actual uſe.

Open chimney fire-places, on the moſt approved principles, will be fitted up as models in the different rooms; and fires will be kept conſtantly burning in them during the cold ſeaſon. Ornamental as well as economical grates, for open chimney fire-places, will alſo be exhibited; ornamental ſtoves, in the form of elegant chimney-pieces, for halls, drawing-rooms, eating-rooms, &c.

Working models of the ſteam engine; of brewer's boilers; of diſtiller's coppers with improved condenſers; of large boilers for the kitchens of hoſpitals; and of ſhip's coppers; all with improved fire-places.

Models of ventilators; of hot-houſes; of lime kilns; of boilers, ſteam-boilers, &c. for preparing food for cattle that are ſtall-fed; of cottages.

Various ſpinning-wheels and looms, with ſuch other machinery as may be uſeful in giving the poor employment at home.

Models of all ſuch new-invented machines and implements as bid fair to be of uſe in huſbandry; of bridges, on various conſtructions; and of all ſuch other machines and uſeful inſtruments as the managers ſhall deem worthy of the public notice:—each article exhibited to be accompanied with a deſcription of it properly illuſtrated by correct drawings, the name of the maker, the place of his abode, and the price.

A lecture-room will be fitted up, and a complete laboratory and philoſophical apparatus, with the neceſſary inſtruments, be provided for making chemical and other philoſophical experiments.

Men of the firſt eminence in ſcience will be engaged as lecturers; and no ſubjects be permitted to be diſcuſſed but ſuch as are ſtrictly ſcientifical, and immediately connected with that particular branch of ſcience publicly announced as the ſubject of the lecture.

Among

Among the branches of ſcience that will occaſionally be made the ſubjects of theſe public lectures, are the following:

Of heat, and its application to the various purpoſes of life; of the combuſtion of inflammable bodies, and the relative quantities of heat producible by the different ſubſtances uſed as fuel; of the management of fire and the economy of fuel; of the principles of the warmth of clothing; of the effects of heat and of cold, and of hot and of cold winds, on the human body, in ſickneſs and in health; of the effects of breathing vitiated and confined air; of means to render dwelling-houſes comfortable and ſalubrious; of the methods of procuring and preſerving ice in ſummer, and of the beſt principles for conſtructing ice-houſes; of the means of preſerving food in different ſeaſons and climates; of the means of cooling liquors without the aſſiſtance of ice; of vegetation, and of the ſpecific nature of thoſe effects that are produced by manures; and of the art of compoſing manures, and adapting them to the different kinds of ſoil; of the nature of thoſe changes that are produced on ſubſtances uſed as food in the various proceſſes of cookery; of the nature of thoſe changes which take place in the digeſtion of food; of the chemical principles of the proceſs of tanning leather, and of the objects that muſt particularly be had in view in attempts to improve that moſt uſeful art; of the chemical principles of the art of making ſoap; of the art of bleaching; of the art of dyeing; and, in general, of all the mechanical arts, as they apply to the various branches of manufacture.

The money neceſſary for defraying the expence of forming this Inſtitution, and alſo for the future expence of keeping it up, is to be raiſed: 1ſt, By the ſums ſubſcribed by the original founders and ſole proprietors of the Inſtitution, at fifty guineas each perſon, to be but once paid. 2dly, By the ſums contributed by thoſe who ſhall ſubſcribe for life, at ten guineas each perſon, to be but once paid. 3dly, By the ſums contributed by the annual ſubſcribers, at two

guineas per annum for each perſon. 4thly, By the particular donations and legacies. And laſtly, by ſums received at the door from ſtrangers who viſit the Repoſitory, or obtain leave to frequent the Lectures.

Each original ſubſcriber or proprietor, beſides other privileges, will be an hereditary governor of the Inſtitution; have a perpetual transferable ſhare in all the property belonging to it; a voice in the election of the managers of the Inſtitution, as alſo in the election of the committee of viſitors; two transferable tickets of perpetual admiſſion into the eſtabliſhment, and into every part of it; two transferable tickets of admiſſion to all the public philoſophical lectures and experiments; and may recommend perſons for admittance to the philoſophical lectures and experiments.

Each ſubſcriber for life will receive one ticket for life, but not transferable, of free admiſſion into the Inſtitution, and into every part of it; together with one other ticket for life, but not transferable, of free admiſſion to all public philoſophical lectures and experiments.

Each annual ſubſcriber's tickets will be for one year, but not transferable.

Subſcribers for life, and annual ſubſcribers, as well as the proprietors of the Inſtitution, will be entitled to have copies or drawings (made at their own expence) of any of the models in the repoſitory, and this even when ſuch copies are deſigned for the uſe of their friends; and workſhops will be prepared, and workmen provided under the direction of the managers for executing ſuch work properly, and at reaſonable prices.

Perſons employed in executing work after any of the models, will, on the recommendation of any ſubſcriber, be allowed acceſs to ſuch model as often as ſhall be neceſſary: and ſuch of them as ſhall be willing to furniſh to buyers any article exhibited in the repoſitory, will be allowed to place a ſpecimen in the repoſitory, with his name and place of

abode attached to it, and the price at which he can furniſh it; ſuch ſpecimen having been examined and approved by the managers.

The deſign or object of the Inſtitution is not to give rewards to the authors of ingenious inventions, but to diffuſe the knowledge of ſuch improvements as bid fair to be of general uſe, and to facilitate the general introduction of them; and to excite and aſſiſt the ingenious and the enterpriſing by the diffuſion of ſcience, and by awakening a ſpirit of inquiry.

In order that the proprietors of the Inſtitution, and the ſubſcribers, may have the earlieſt notice of all new diſcoveries and uſeful improvements that ſhall be made from time to time, not only in this country, but alſo in all the different parts of the world, the managers will employ the proper means for obtaining, as early as poſſible, from every part of the Britiſh empire, and from all foreign countries, authentic accounts of all ſuch new and intereſting diſcoveries in the various branches of ſcience, and in arts and manufactures, and alſo of all ſuch new and uſeful mechanical improvements as ſhall be made; and a room will be ſet apart in the Inſtitution, where all ſuch information will be lodged, and where it will be kept for the ſole and excluſive uſe and inſpection of the proprietors and ſubſcribers, and where no ſtranger will ever be admitted.

Several reſolutions adopted at a general meeting of the proprietors, held at the houſe of the Right Honourable Sir Joſeph Banks, Bart. K. B. in Soho Square, on the 7th day of March 1799, having been publiſhed in the daily papers, need not be here repeated.

The following liſt of the proprietors, and original ſubſcribers of 50 guineas each, deſerves, however, to be recorded in the preſent account of the Inſtitution:

Sir Robert Ainſlie, Bart.	Scrope Bernard, Eſq. M.P.
I. J. Angerſtein, Eſq.	The Earl of Beſborough.
Right Hon. Sir Joſeph Banks, K. B.	Rowland Burdon, Eſq. M. P.
Thomas Bernard, Eſq.	James Burton, Eſq.

Timothy

Timothy Brent, Eſq.
Henry Cavendiſh, Eſq.
Rich. Clark, Eſq. Chamb. of Lond.
Sir John Colpoys, K. B.
John Craufurd, Eſq.
The Duke of Devonſhire, K. G.
Andrew Douglas, Eſq.
The Lord Biſhop of Durham.
The Earl of Egremont.
George Ellis, Eſq. M. P.
Joſeph Grote, Eſq.
Sir Robert Bateſon Harvey, Bart.
Sir John Cox Hippeſley, Bart.
Henry Hoare, Eſq.
Lord Hobart.
Lord Holland.
Henry Hope, Eſq.
Thomas Hope, Eſq.
Lord Keith K. B.
William Luſhington, Eſq. M. P.
Sir John Macpherſon, Bart. M. P.
William Manning, Eſq M. P.
The Earl of Mansfield.
The Earl of Morton, K. T.
Lord Oſſulſton.
Thomas Palmer, Eſq.
The Lord Viſcount Palmerſton, M. P.
Edward Parry, Eſq.
Right Hon. Thomas Pelham, M. P.
John Penn, Eſq.
William Morton Pitt, Eſq. M. P.
Sir James Pulteney, Bart. M. P.
Sir John Buchanan Riddell, Bart.
Count Rumford.
Sir John Sinclair, Bart. M. P.
Lord Somerville.
John Spalding, Eſq. M. P.
The Earl Spencer, K. G.
Sir George Staunton, Bart.
John Sullivan, Eſq.
Richard Joſeph Sulivan, Eſq.
Lord Teignmouth.
John Thomſon, Eſq.
Samuel Thornton, Eſq. M. P.
Henry Thornton, Eſq M. P.
George Vanſittart, Eſq M. P.
William Wilberforce, Eſq. M. P.
The Earl of Winchelſea.
Hon. James Stuart Wortley, M. P.
Sir William Young, Bart. M. P.

The following proprietors have been elected as the firſt managers of the Inſtitution.

For three years: The Earl Spencer; Count Rumford; Richard Clarke, Eſq.——For two years: The Earl of Egremont; Right Hon. Sir Joſeph Banks; Rich. Joſeph Sulivan, Eſq.——For one year: The Earl of Morton; the Right Hon. Thomas Pelham; Thomas Bernard, Eſq.

At a meeting of the Managers held on the 9th of March, it was reſolved, among other things, That the Earl of Morton, the Earl Spencer, Sir Joſeph Banks, and Mr. Pelham, ſhould be requeſted to lay the Propoſals for forming the Inſtitution before his Majeſty and the Royal Family, and before his Majeſty's Miniſters and the Great Officers of State;—and, That the Propoſals for forming the Inſtitution be laid before the Members of both Houſes of Parliament, and alſo before the Members of his Majeſty's Moſt Honourable Privy Council, and the Twelve Judges.

COW-POX.

WE have already given an account of Drs. Jenner and Pearſon's publications on the cow-pox, which tended to eſtabliſh the important fact, that thoſe who have had that diſeaſe, which never proves fatal, and which may always be ſo managed as never to diſfigure the patient, are not capable of afterwards taking the ſmall-pox infection—a fact which, if properly followed up, promiſes fair to extirpate the latter diſeaſe, to which more have fallen victims than to the peſtilence itſelf. Drs. Pearſon, Jenner, and Woodville, with a zeal that does them great honour, have ſince beſtowed much attention and labour in aſcertaining, by proper trials, how far it is prudent to perſevere in ſubſtituting a diſeaſe that has hitherto appeared no way dangerous, for one that ſo often proves mortal; and, we are happy to add, with a ſucceſs equal to the moſt ſanguine expectations that could have been formed: in conſequence of which, the following circular letter has been addreſſed to the gentlemen of the faculty:

Sir, Leiceſter Square, March 12, 1799.

I hope you will pardon me for taking the liberty to inform you, by way of additional evidence to the teſtimonies I have publiſhed on the ſubject of the cow-pox, that upwards of one hundred and ſixty patients, from two weeks to forty years of age, principally infants, have been inoculated ſince the twentieth of January laſt by Dr. Woodville and myſelf ſeparately.—I ſhall at preſent only communicate the following obſervations:

1. Not one mortal caſe occurred.—2. Not one of the patients was conſidered to be dangerouſly ill.—3. Although the extreme caſes of the ſevere kind which ordinarily occur in the ſame number of caſes in the inoculated ſmall-pox did not occur in the above practice, and although many of the patients were even more ſlightly diſordered conſtitutionally, yet the whole amount of the conſtitutional illneſs ſeemed to be as great as in the ſame number of patients in the inoculated

lated small-pox.—4. None of the patients, namely, above sixty, hitherto inoculated for the small-pox, subsequently to the vaccine disease, took the infection.—5. One of the most important facts is, that the local affection in the inoculated part, on the whole, was less considerable, and of shorter duration than in the inoculated small-pox.—6. In many of the cases eruptions on the body appeared, some of which could not be distinguished from the small-pox.

I have sent the matter of the cow-pox pustule on the thread inclosed, in order, if you approve of the inquiry, to inoculate with it; and I entreat you to favour me with the result of your trials: but I must trouble you to apply the test of inoculating with variolous matter subsequently to the vaccine disorder.

I have the honour to be, &c. &c. &c.

G. Pearson.

P. S. I am happy to be able to state, that at Berkeley Dr. Jenner has continued his trials of inoculation with vaccine matter, sent from London, with good success.—I should have given you a more circumstantial account of the cases here alluded to, but I think it unnecessary, as Dr. Woodville has a pamphlet in the press on the subject.

THE NEW INSECT.

IN our last we informed our readers that a new insect had appeared within these few years in this country, which threatens the entire destruction of all our apple-trees, if means be not generally followed for extirpating it. In the hurry of the press a material ingredient was omitted in Mr. Forsyth's recipe: we therefore reprint it more correctly.

℞. To 100 gallons of human urine and 1 bushel of lime add cow-dung to bring it to the consistence of paint. With this composition anoint the trees. The present is the proper season for applying it. If the white efflorescence-like substance in which the insects are lodged has made its appearance, it should previously be brushed off.

THE

PHILOSOPHICAL MAGAZINE.

APRIL 1799.

I. *Obſervations on Living Animals found incloſed in Stones and other ſolid Subſtances.* *By* F. W. A. MURHARD. *From* Magazin für das neueſte aus der Phyſik. *Vol. XI.*

OF living animals being found incloſed in ſolid maſſes, I have met with no mention in the works of the ancients. Martial, indeed, in one of his epigrams, ſpeaks of inſects incloſed in amber; but theſe animals were dead, and therefore do not belong to this ſubject. As far as I know, Fulgos * is the firſt author who makes mention of a living toad being found incloſed in a ſtone. He wrote about the beginning of the ſixteenth century; and the circumſtance took place in the village of Meudon in Italy, in the time of Pope Martin V. He was informed by a ſtone-cutter that there was nothing ſurpriſing in it, as ſuch phenomena had often occurred to himſelf. Agricola, who lived afterwards, ſpeaks of poiſonous frogs being found in ſtones, but which ſoon died when expoſed for a ſhort while to the air. Aldrovandi † alſo ſpeaks of marble in which theſe animals were found

* See his work *De Mirabilibus*. Mediol. 1509, fol. and Antverp. 1565. 8, in the chapter *De avibus animalibuſque aliis admirandis*.

† Aldrovandi De Teſtaceis, p. 81.

alive. Ray* at firſt doubted the truth of theſe relations; but his doubts were ſoon removed by the undubitable teſtimony of eye-witneſſes. Accounts of a ſimilar kind may be found in Franciſci's *Theatre of Various Curioſities*, printed at Nuremberg in 1671†. The author there ſpeaks of toads, crabs, ſerpents and ſhell-fiſh found in ſtones; but it is very evident that he confounds theſe with petrifactions.

Lloyd, in the third letter at the end of his *Lithophylacii Britannici Ichnographia*‡, ſays, he was informed by Dr. Richardſon that he had found a living toad incloſed in a ſolid rock. Dr. Bradley§ mentions a fact of the like kind, having been witneſs to a toad being found in the trunk of a large oak. We are told in the Hiſtory of the Academy of Sciences of Paris for the year 1719, that a toad was found incloſed in an elm as thick as a man's body. As ſoon as the trunk was cleft the animal dropped out, and no opening could be diſcovered through which it had got in to the heart of the wood. A ſimilar circumſtance is mentioned in the ſame work for 1731, viz. of a toad being found in an oak at leaſt eighty or a hundred years old‖.

Labat, in his Travels through Spain and Italy¶, gives a very minute deſcription of a kind of ſhell-fiſh found in ſtones fiſhed up from the ſea in the territories of Civita Vecchia, and which were eaten by the inhabitants. "While walking," ſays he, "on the coaſt of Bichiere, I had the pleaſure of ſeeing fiſhed up ſeveral ſea dates (*dattoli di mare*) which are produced and grow in certain ſtones of a ſome-

* Synopſis Animal. Quadruped. p. 21.

† Der luſtigen Schau-Bühne vielerhand Curioſitaten 2ter Theile durch Eraſmum Franciſci. Nuremberg, 1671.8. p. 1109.

‡ Lond. 1698.8, p. 107.

§ A Philoſophical Account of the Works of Nature. Lond. 1721. 4to. p. 9 and 120. See alſo Acta eruditorum. Lip. 1721. p. 370.

‖ See alſo Acta eruditorum. Lip. Suppl. VIII.

¶ Voyages en Eſpagne et en Italie. Amſt. 1731.8. vol. iv. p. 240.

what

what ſpongy nature, found in great abundance in the Adriatic Sea, and of which there are ſome alſo in the port of Civita Vecchia. Theſe ſea dates, which are a kind of muſcles, are almoſt round, pointed at both ends, and conſiſt of two ſhells which open on one ſide, and are from one or two to nearly four inches in length. The ſhell is of the ſame quality as that of the common muſcle, but it is a little browner and leſs ſmooth on the outſide. The inſide has a ſomewhat ſilvery appearance. The fiſh which they contain is white, delicate, fat, and of a very agreeable taſte, ſo that it is a morſel for a cardinal (*un boccone di cardinale*). They are called dates, becauſe the ſhell which contains the fiſh has a great reſemblance to the dates of Barbary when they are ripe and dried. The ſtone in which they are incloſed is heavy and pretty ſolid, though it appears ſpongy. The cavity which the ſhell occupies in the ſtone, and which it exactly fills, touches it on all ſides like the beſt fitted caſe. Some ſmall ones are not half an inch in length, but others are four inches. When the fiſhermen had procured a ſufficient number of the ſtones, they placed them on the edge of the quay, and broke them by means of a large hammer. In ſome they found nothing, but others contained two or three dates. They gave ſome of them to me, together with fragments of the ſtone which incloſed them, and on which I made the above obſervations."

Inſtances of a ſimilar kind may be found alſo in various other works. Thus we are told that Charles Hall, a merchant at Eberach, ſaw a living toad ſitting in a ſtone, upon its being broken. Martin Weinreich * relates a circumſtance of the like kind; and John Nardius † ſays, that he found in a block of marble a living ſnake. Libavius ſpeaks of vipers and toads found in ſtones, as does alſo Cardan. A living

* Commentar. de Monſtris, cap. vii. p. 58.

† Joan. Nard. in Ann. 1. noct. gen. 4. p. 266.

toad was found in an oak by Seigne in 1731, and another in a hard ſtone, at Ecretteville, by Le Prince in 1756*.

A great many particulars relating to this ſubject have been collected by Guettard. A common toad, two of whoſe feet were free, and the other two ſticking faſt in gypſum, ſo that it was impoſſible to diſengage them without tearing them to pieces, was ſent to him by order of the Duke of Orleans. Count Hermann II. of Hatzfeld, told Dr. Sachſen † that he heard a living frog croak in the middle of a ſtone at his palace of Schellenberg, near Cologne, and that the animal hopped out on the ſtone burſting of itſelf. I ſhall now give a few other inſtances, of which Guettard makes no mention.

In the year 1733 a living toad was found by J. M. Gräberg in a ſolid hard block of ſtone, dug up from a quarry in the pariſh of Wamblingebo, in Gothland, and which he cauſed to be broken by the workmen. The colour of the animal was blackiſh grey, a little ſpotted on the back, and ſomewhat fainter on the belly. Its eyes were ſmall and round, and covered by a tender ſkin or film, under which they ſeemed to ſparkle a little with a colour like that of pale gold. Having touched it on the head with a ſtick, it contracted its eyes as if it had been aſleep: as ſoon as the ſtick was removed, it gradually opened them; but moved neither its body nor feet in the leaſt, though he touched it different times. He remarked alſo that the mouth had no aperture. It was covered with a yellowiſh ſkin, which he examined alſo with the ſtick, but he was not able to make it

* Inſtances of the like kind may be found in the following works: *Haller de corp. hum. fabr. et funct.* vol. vii. p. 157; *Avant Coureur*, 15 Sept. 1766; *Chr. Franc. Paulini in Buſone*, c. 3. *ſect.* i. p. 33; *Chriſt. Fr. Garmann in Oolog. curr. diſs.* ii. p. 145. § 120; *Nierenberg. Hiſt. Nat.* lib. vi. c. 13; *D. Buſchius de Aetite*, p. 74; *Euſeb. Chriſt. Frankens Hiſtorie der Grafſchaft Mannsfeld*, Leip. 1723. vol. i. ch. 5; *Leſſers Lithotheologie*, Hamburgh 1751. 8. p. 101 and 112.

† Memoires ſur differens parties des Sciences et des Arts. Paris 1783. 4. vol. iv. p. 615.

open

open it. Having at laſt preſſed it on the back, a little clear water iſſued from it behind, upon which it immediately died *. Don Antonio de Ulloa, who with Condamine, Bouguer and Godin, was employed in meaſuring a degree of the meridian in Peru, ſaw at Madrid two worms which had been found in the middle of a block of marble by the king of Spain's ſtatuary. Miſſon, in his Travels through Italy, ſpeaks of a living crab found in a piece of marble near Tivoli. M. Peyſonnel, phyſician to the king of France, having employed ſome workmen to dig a well near his houſe in Guadaloupe, they found living frogs amidſt the ſtrata of the rock. His curioſity being excited by this circumſtance, he deſcended into the well himſelf, bored into the rock, and brought up alive ſome green frogs, which had a perfect reſemblance to the common ones.

In the Gentleman's Magazine for 1756 mention is made of a living toad found in a block of marble, at an old caſtle belonging to Lord Tankerville, twelve miles north-weſt from Alnwick †. T. Whiſton relates, that in the year 1743 a ſtone-cutter named Charlton found near Wiſbich, in the Iſle of Ely, a living toad incloſed in a piece of marble ‡. Being called to the ſpot, he ſaw the animal, and the cavity in which it was contained. The latter was ſomewhat larger than the toad, and had almoſt the ſame figure. The animal was of a dark yellow colour; and the ſolid marble, which incloſed it on all ſides, was ſeveral inches thick. It ſeemed to be quite healthy, and by its long confinement had not become meagre. John Malpas alſo, in the year 1755, found a living toad incloſed in a piece of free-ſtone at Great Yarmouth §. The hole in which it lay was ſix inches diſtant from the corner of the ſtone. He took it out with a pair of

* Kongl. Swenſka Vetenſkaps Academiens handlingar for ar 1741. p. 248.

† Gentleman's Magazine, 1756, p. 74.

‡ Ibid. May 1756, p. 240.

§ See Gentleman's Magazine, loc. cit.

compaſſes, but in doing ſo happened to hurt it. When he placed it on the ground it however crept about, but died in the courſe of an hour. It had a yellow ſtripe over the back, the colour of which became changed after it was dead. No crack or cleft could be diſcovered in the ſtone. The inſide of the cavity was ſmooth, and looked as if it had been poliſhed.

M. Gerhard, at Padenburg, in the county of Mansfeld, ſaw likewiſe a living toad incloſed in a ſtone. The cavity in which it lay ſeemed exactly fitted to the ſize of the animal, but was exceedingly ſmooth in the inſide. No opening could be obſerved through which it was poſſible for it to have got into the ſtone. After ſome ſearch, however, a hole was diſcovered at the ſurface of the earth, which extended to the depth of twelve toiſes; but ceaſed at the diſtance of thirteen inches above the cavity that contained the toad. M. Gerhard conſiders it as very probable that this aperture had formerly extended to the cavity, into which the egg of a toad might have been conveyed by water; and that the opening muſt afterwards have been cloſed up near the cavity. The toad, however, muſt have remained long in this ſtate; for ſuch apertures do not cloſe up ſoon, and a long time is required for the petrifaction of earthy particles *.

M. le Cat †, who relates many inſtances of the like kind, examines the poſſibility of them, and the cauſes of ſuch phenomena. Some philoſophers have been of opinion, that the eggs of theſe animals, created by the Supreme Being at the beginning of the world, and floating about on the watery expanſe, have ſince that time been incloſed in the interior parts of the rocks. But M. le Cat contradicts this opinion by remarking that the creation of an egg is not ſufficient, and that it muſt be hatched in order to produce a living creature. He conſiders it alſo as impoſſible that ſuch ani-

* See Nouveaux Memoires de l'Acad. des Sciences et Belles Lettres de Pruſſe pour l'année 1782. Berlin 1784, 4to. p. 13.

† In Du Lac Melanges d'Hiſtoire Naturelle, vol. iv. p. 615.

mals

mals can be of the same antiquity as the stones or substances in which they are found. The age of the oldest men, says he, never exceeded 169 years; and what is the life of an insect when compared with that of man? Even if we suppose that the moderation of these animals, and their being exposed to very little motion, had caused their growth and the periods of their life to be extended in an uncommon degree; and though their want of air, or rather their being preserved and defended from the manifold impressions of that corrupted element, had contributed a great deal to their support, the prolongation of life thence arising could not exceed so very much their natural and usual existence. M. le Cat rather thinks that a hatched egg, in all the cases mentioned, may have fallen by chance into some small cavity, where it was secured from petrifaction till its substance acquired sufficient strength. He here remarks that eggs, when rubbed over with varnish so as to be defended from the effects of the air, may be preserved fruitful for years; and he therefore believes, on good grounds, that an egg so secured in the centre of a rock might retain its activity for some thousands of years, and even that it would be impossible for it to be hatched till it had been exposed to a very high degree of often renewed or long continued heat. According to M. le Cat's opinion it is the egg which is of great antiquity, and not the animal. I shall here observe that nature, when allowed peace and rest, does not require so much time as is generally believed in order to produce minerals. Of the truth of this remark I am fully convinced, since I saw in the museum at Göttingen the step of a ladder found on clearing the gallery of a mine in Rammelsberg, abandoned at most about 100 years before, and which in the course of that period had been encrusted with selenite seven inches in thickness. Nay we have instances of ore having grown up in a much shorter time *.

* See *Ulloas Nachricht von America*, vol. ii. p. 14, and *Trebras Erfahrungen vom Innern der Gebürge*, p. 53, tab. 4, no. 4.

I muſt obſerve alſo, that moſt of the animals found in this manner were of the amphibious kind, and requeſt the reader to reflect on the habits, nature and mode of living peculiar to that claſs. Caldeſi relates, that tortoiſes can endure hunger for half a year; and numberleſs inſtances might be produced of their ſtrong and tough nature.

I ſhall not enlarge farther on this ſubject at preſent, as I mean at ſome future period to communicate my ideas to the public in a more connected manner, and to give as complete a theory on it as poſſible. I flatter myſelf that I am the more qualified for this taſk, as many have written on theſe phenomena and formed conjectures without having ever ſeen one inſtance, while I have been an eye witneſs of ſome of the lateſt. In a quarry not far from Caſſel, between that city and the palace of Freyenhagen, I found three toads together in a pretty large block of free-ſtone *. I remember, alſo, that, when a boy, our houſe at Caſſel being under repair, and the old plaſter pulled down, ſeveral toads were found between it and the ſtone wall †.

At a period like the preſent, when ſo many things are made the ſubject of experiment, when every one endeavours to tread in the footſteps of a Bacon and a Newton, and, inſtead of being contented with ſurveying Nature in her private receſſes and carefully watching her progreſs, compels her as it were to labour and make known her ſecrets, I am much aſtoniſhed that ſhe has not been put to the proof in this reſpect long ago. Such experiments, without which all theory muſt ever remain mere hypotheſes, and can never amount to demonſtration, would require little or no expence. Nothing would be neceſſary but to make a deep hole in a ſtone; to incloſe ſome animal in it, ſuch for example as a

* See Diſſ. Academicor. Inſtitut. Bonon. (interp. Beccario) op. Benedict. XIV. P. M. de Sevor. Dei beatificat. l. iv. p. 1. p. 328; and Beccarius in Commentar. Inſtit. Bonon. tom. ii. p. 1. p. 323.

† A full account of this circumſtance, which I tranſmitted to M. Kaſtner, may be found in the *Gottingiſch. Anzeig.* for 1796.

toad, and to prevent the air from penetrating to it: or eggs only might at firſt be put into the ſtone. It would, however, be attended with moſt advantage if ſeveral experiments were made at the ſame time, in order that the ſtate of the animals might be examined at different periods. Such experiments, and careful obſervation of the nature and economy of theſe animals, could alone lead to any certain concluſion reſpecting a circumſtance ſo abſtruſe, which, at preſent, ſeems to ſurpaſs the powers of our comprehenſion.

II. *Obſervations on Snow and Rain; their Influence on Vegetation, and their Combination with Oxygen. By* J. H. Hassenfratz. *From* Journal de L'Ecole Polytechnique, *P. IV.*

All thoſe who inhabit parts of the earth expoſed to ſnow, agree in conſidering this meteor as one of the means employed by nature to give to plants more ſtrength, and to make them expand with more vigour. Several even are perſuaded that winters which produce no ſnow preſage a bad harveſt and a feeble ſtate of vegetation; and they aſcribe its influence to the ſalts which they ſay exiſt in that congealed water. Snow collected in large maſſes, melted and evaporated in earthen veſſels, having left no reſiduum, has made this ſuppoſition be conſidered as a mere chimera; and, in conſequence of reaſoning carried too far, ſome have been induced to deny that ſnow has any influence at all on vegetation.

In phenomena tranſmitted through ſucceſſive generations, we muſt diſtinguiſh the reſults of obſervation from the explanations ſome have attempted to give of them. There are phenomena, indeed, the whole of which preſent themſelves to our ſenſes in their full force, and which can leave no doubt in the mind of the leaſt attentive obſerver; but there are others which exhibit only a few traces that cannot be diſ-

diſtinguiſhed, unleſs by particular inſtruments, or after a ſeries of obſervations often repeated. When theſe traces have been obſerved by a great number of individuals, for ſeveral generations, however incorrectly tranſmitted, and however obſcure may be the tradition, the philoſopher muſt beware of deciding too raſhly. The greater the number of obſervers, the more perfect is the uniformity of their opinions reſpecting the phenomenon, and the more careful ought people to be in their diſcuſſions before they venture to contradict them.

The influence of ſnow on vegetation has been ſubjected to the examination of too many obſervers, to allow us to believe it poſſible that there could be ſo great an uniformity in their opinions, were not the effects really ſuch as are ſuppoſed. In this memoir, then, I ſhall examine theſe effects; I ſhall endeavour to explain the cauſe of them, and ſhall enquire what relation there is between the explanation given long ago by farmers and a more accurate analyſis of ſnow.

That, after a very cold and very ſevere winter, vegetation is ſtronger and more active in proportion as plants have been covered with a greater depth of ſnow is a certain fact, proved by the reſult of the experience of every one engaged in agriculture. The cauſe is ſimple and natural. All plants are capable of ſupporting cold in a leſs or a greater degree; there are ſome which cannot be expoſed to the temperature of melting ice without periſhing, and there are others on which the moſt intenſe cold produces no alteration. Each plant then has certain limits to its reſiſtance of cold; a certain temperature beyond which it cannot be expoſed to it without the danger of being frozen and deſtroyed. Several plants expoſed to a temperature nearly equal to that which muſt congeal them do not periſh, but, by the ſharpneſs of the cold which they experience, contract a languiſhing diſeaſe, the effects of which they feel during the whole courſe of their exiſtence.

If we expoſe to the action of great cold a ſeries of plants capable

capable of ſupporting different degrees of it, there will periſh in that ſeries a greater number in proportion as the cold has been greater; but if, by means of a covering, we intercept the cold, and prevent the plants from being expoſed to a diminution of heat as great as that which exiſts without, ſeveral plants which would otherwiſe have periſhed will be preſerved; ſeveral of thoſe which would have been diſeaſed will be healthy and vigorous, and their number will be greater in proportion as the covering has intercepted a greater degree of cold.

The earth has a heat accumulated in its interior parts: this heat is perceived in all ſubterranean places of ſufficient depth to prevent the external cold or heat from penetrating thither. This temperature is equal to 13° on the decimal ſcale of the mercurial thermometer (55·4 Fahr.). Snow is a bad conductor of heat; cold penetrates it with difficulty, and its temperature when it melts is zero. When the ſurface of the earth is covered to a conſiderable depth with ſnow, the cold of the atmoſphere, in contact with it, tends to cool its maſs; and the internal heat of the earth tends to warm it. Through the maſs of ſnow there is then a conteſt of heat and cold, the uſual reſult of which is to melt a portion of the ſnow, and to carry to zero the temperature of the middle, in which the plants are ſituated.

Thus ſnow has the property of keeping the plants which it covers at the temperature of melting ice; of preſerving them from the influence of a greater cold; of ſupplying them with continual moiſture; of preventing a great number from periſhing, and ſtill more from languiſhing; and, conſequently, of giving more ſtrength and vigour to vegetables than they would have obtained had they not been covered with ſnow. It appears then that we may explain a part of the influence which ſnow has upon vegetation, without having recourſe to the ſalts or nitre which it is ſaid to contain, and which analyſis and experiments have proved do not exiſt.

The explanation of the influence of ſnow by the continual humidity it ſupplies to plants, is the reſult of obſervations which cannot have eſcaped intelligent farmers in all ages; but a knowledge of the influence it has by being a bad conductor of heat, is the conſequence of experiments recently made on caloric. The ancients had neither a ſeries of facts nor inſtruments proper for ſuch reſearches. They obſerved, that the atmoſphere ruſted metals in the ſame manner as acids; from which they concluded, that the air contained an acid. They remarked, that nitre was formed ſpontaneouſly on calcareous maſſes; from which they concluded, that the acid of the atmoſphere was a nitre: and this concluſion was not far from the truth, ſince the lateſt experiments, and moſt remarkable diſcoveries which have contributed in the higheſt degree to the rapid progreſs of phyſics, have proved that the air is formed of two elements, which enter into the compoſition of the nitric acid, viz. oxygen and azot. Let us acknowledge, therefore, that the philoſophers who preceded us poſſeſſed no little acuteneſs and ſagacity to be able to diſcover, ſo long ago, by the accumulation of ſeveral indirect experiments, what the moſt accurate analyſis demonſtrates at preſent.

If ſnow poſſeſſed only the property of preſerving vegetables, and of preventing them from periſhing by the ſeverity of the cold, it is not at all probable that the ancient philoſophers would have conſidered it as depoſiting on the earth nitrous ſalts, as they might have aſcertained, by a very ſimple experiment, that it contains none of that ſalt; for they did not aſcribe the ſame property to rain-water, but they remarked that ſnow burnt the ſkin in the manner of acids, as well as other bodies immerſed in it. Being induced to conclude that there was nitre in the air, it was natural that they ſhould aſcribe to this nitre the burning qualities of ſnow, and conſequently its influence on vegetation.

C. Guyton having engaged me to examine the cauſe of the difference of the effects of ſnow and rain-water on va-

rious

rious ſubſtances, I found that they were occaſioned by the oxygenation of the ſnow; and that theſe effects were to be aſcribed to a particular combination of oxygen in this congealed water. I put 1000 grammes of ſnow in a jar, and 1000 grammes of diſtilled water in another. I poured into each of the jars an equal quantity of the ſame ſolution of turnſole. I placed both the jars in a warm temperature, and, after the ſnow melted, I remarked that the dye was redder in the ſnow water than in the diſtilled water. I repeated this experiment, and with the ſame reſult. I put into a jar 1000 grammes of diſtilled water, and into another 1000 grammes of ſnow. Into each of the jars I put 6·5 grammes of very pure and clean ſulphat of iron. In the firſt there was precipitated 0·150 grammes of the oxyd of iron, and 0·010 grammes in the other. As the oxyd of iron was precipitated from a ſolution of the ſulphat by oxygen, it thence follows, that the ſnow contained more oxygen than the diſtilled water; and it follows from the firſt experiment, that this quantity of oxygen was conſiderable enough to redden the tincture of turnſole.

It is fully demonſtrated by theſe two experiments, that ſnow is oxygenated water, and that it muſt conſequently have on vegetation an action different from that of common ice. The experiments of Dr. Ingenhouſs, on the germination of ſeeds, have taught us that the preſence and contact of oxygen are abſolutely neceſſary for the plant to expand. They have ſhewn alſo that the more abundant the oxygen is the more rapidly will the ſeeds grow. Moſt plants ſuffered to attain to their perfect maturity ſhed on the earth a part of their ſeed. Theſe ſeeds, thus abandoned and expoſed to the action of cold, are preſerved by the ſnow which covers them, at the ſame time that they find in the water, it produces by melting, a portion of oxygen that has a powerful action on the principle of germination, and determines the ſeeds that would have periſhed to grow, to expand, and to augment the number of the plants that cover the ſurface of the earth.

A very

A very conſiderable number of the plants which we have the art of appropriating for our nouriſhment and our wants are ſown in the months of Vendemiaire, Brumaire, and even Frimaire (end of September to end of December); ſeveral of theſe ſeeds germinate before the cold commences its action upon them and changes the principle of their life. The ſnow which covers the reſt, acting on the germ by its oxygenation, obliges them to expand and to increaſe the number of uſeful plants which the farmer and gardener commit to the earth, and conſequently to multiply their productions.

Here then we have three effects of ſnow upon vegetation, all very different, which contribute each ſeparately to increaſe, every year, the number of our plants; to give them more vigour, and conſequently to multiply our crops. Theſe effects are: 1. To prevent the plants from being attacked by the cold, and from being changed or periſhing by its force. 2. To furniſh vegetables with continual moiſture, which helps them to procure thoſe ſubſtances neceſſary for their nutrition, and to preſerve them in a ſtrong healthy ſtate. 3. To cauſe a greater number of ſeeds to germinate, and conſequently to increaſe the number of our plants.

Before I conclude, I muſt mention ſome important experiments, in regard to vegetation, which I made on rain-water. Rain-water does not act on tincture of turnſole or on ſulphat of iron like ſnow; from which it would appear that it does not participate in that property which it acquires by oxygenation. Rain-water, however, contains oxygen alſo; but in a ſtate of ſolution, and not of combination, as in ſnow; for under an exhauſted receiver rain-water ſuffers air to eſcape from it, which contains proportions of oxygen much greater than river water, ſpring water, and even atmoſpheric air.

Atmoſpheric air expoſed to the action of phoſphorus, without the application of heat, after the method indicated by Berthollet, is diminiſhed in its bulk 0·20; that is to ſay, the phoſphorus takes from the azot 20 parts of oxygen in

100 parts of atmoſpheric air. Air drawn from the water of the Seine, tried by the ſame eudiometer, gave the ſame diminution. Air drawn from rain water was, on the other hand, diminiſhed by phoſphorus from 0·32 to 0·40. As the mean of a great number of experiments was 0·35, it thence follows that the proportion of oxygen in the air obtained from rain water, newly fallen, is greater and more conſiderable than that contained in atmoſpheric air, and in the air of other water.

Since rain water thus differs from common water by the oxygen it holds in ſolution, and ſince oxygen has an influence on germination, and even on vegetation, as is proved by the experiments of Ingenhouſs and Senebier, it is natural to aſcribe to it a part of the peculiar action which rain has on the vegetation of plants different from that of other water with which they are watered.

III. *On the Component Parts of Iron-ſtones, and how thoſe in the manufacturing affect the Quality of Crude Iron. By* Mr. DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

[Continued from page 210]

HAVING in the former part of this paper ſtated the average loſs which the various natures of iron-ſtones ſuſtain when expoſed to torrefaction in external air, I ſhall now ſimply ſtate the quantity of oxygen which the various claſſes are apt to imbibe when expoſed to a high temperature, after thoſe volatile mixtures capable of aſſuming the gaſeous ſtate by the combination of caloric have been expelled.

The facility with which iron-ſtones become oxydated is entirely dependent upon the nature of the mixture conſtituting fuſibility or otherwiſe: ſo that were argillaceous, calcareous, and ſiliceous iron-ſtones, previouſly de-oxygenated, expoſed to the ſame degree of heat—a degree capable of oxydating their iron—the reſult would be, that the quantity of oxygen combined would be in a relative proportion to the fuſibility

fuſibility of the mixtures, for a determinate ſpace of time. The argillaceous iron-ſtone would be found in a given time to have gained leaſt; the calcareous a larger portion; while the ſiliceous, containing an aſſemblage of mixture fuſible at a degree of heat in which the former would remain unchanged, will be found to have gained the greateſt weight; but if expoſed to an high temperature for a ſufficient length of time, the oxygen abſorbed will be in an exact proportion to the iron contained in the ſtone; only, the ſiliceous iron-ſtones arrive ſooneſt at a high pitch of combination. In the courſe of many experiments I have found the following proportions to be nearly juſt, when the quantity of iron contained in the reſpective ſtones was nearly analogous.

Argillaceous iron-ſtone, which has yielded me 38 per cent. in the aſſay-furnace, firſt diſtilled and afterwards carefully de-oxygenated, increaſed in weight, during an expoſure to ignited gas for 8 hours in the bottom of a deep crucible, 22 per cent.

Calcareous iron-ſtone, which afforded a ſimilar quantity of metal, and which was ſubjected to the ſame train of preparation, to diſpel its volatile mixtures, and unfix its oxygen, gained in weight nearly 23 per cent.

Siliceous iron-ſtones, containing from 36 to 38 parts of iron in 100, treated in the ſame manner, afforded me inſtances of an accumulation of weight equal to 24 to 25 per cent.

In order more particularly to illuſtrate the double phenomenon of iron-ſtones firſt loſing and then gaining weight, I ſhall inſert the treatment of one particular ſtone of each claſs; from which a poſitive judgment may be formed of the general operation, and reſults, peculiar to each.

1. There were introduced into an iron teſt ſome pieces of argillaceous iron-ſtones, weighing - - 1750 grs.

After being expoſed to a bright red heat for 8 hours, and then allowed to cool, they weighed 1160

Loſt in ſimple diſtillation - - - 590 grs.

Equal to 33·6 per cent. Specific gravity in this ſtate 2,52150.

The

The ſtone had now aſſumed a claret colour, and was poſſeſſed of regular internal fibres, adheſive to the tongue, obedient to the magnet, and exhibiting every property peculiar to excellent iron-ſtone.

I returned the reſidue, which, as above, weighed 1160 grs. and expoſed it in an open crucible for 4 hours to an increaſing heat till a ſlight degree of fuſion was perceived to take place. This was indicated by the angles of the pieces becoming rounded, and ſwelling a little in bulk—When cool they were found ſlightly porous, and weighed - 1309

Increaſed in weight by the combination of oxygen - - - - 149 grs.

Equal to 12·8 per cent. Specific gravity in this ſtate 3·3636.

The fracture of the pieces now wore a ſemi-vitrified appearance, of a dark blue colour, refractory to part, inadheſive to the tongue, unmagnetic, but much more metallic and ponderous. A calcareous iron-ſtone treated after the ſame manner, of which I alſo uſed ſmall pieces, weighing - - - - - 1750 grs. which had yielded a ſimilar product in iron in the aſſay-furnace with the former, when cool weighed - - - - 1090

Loſt in ſimple diſtillation equal to 37·7 per cent. - - - - 660 grs.

The fracture of this iron-ſtone was now of a bright brown colour, ſtreaked with lime, faintly marked with internal fibre, leſs tenacious to the tongue than the former claſs, but equally obedient to the magnet.

The reſidue, weighing as above - - 1090 grs.
was returned to the furnace, and expoſed in the bottom of a deep crucible, till ſuch time as a ſlight indication of fuſion was obſerved; when cooled, the pieces weighed - - 1235

Gained in weight by the fixation of oxygen equal to 13·3 per cent. - - - 145 grs.

In its preſent ſtate this iron-ſtone, in point of colour, reſembled the former.

Its fracture, however, was ſmoother, and more vitrified, equally deſtitute of tenacity to the tongue, and obedience to the magnet.

3. An iron-ſtone, which contained a large proportion of ſand, was expoſed under ſimilar circumſtances to the ſame degree of heat—Quantity uſed weighed alſo - 1750 grs.
When properly torrefied, weighed - - 1248

Loſt in ſimple diſtillation equal to 28·6 per cent. - - - - 502 grs.

The appearance which this ſtone had aſſumed was of a reddiſh, ſmall, granulated fracture, conſiderably magnetic, but ſcarcely poſſeſſing any degree of adheſion to the tongue.

The reſidue, weighing as above - - 1248 grs.
was expoſed to an equal degree of heat with the former claſſes, by which the ſtone ſuffered throughout a ſlight degree of fuſion—when cool, the connected maſs weighed - 1431

Gained in weight by the combination of oxygen equal to 14·6 - - - 183

The colour of the ſtone was now changed to a black, vitreſcent, ſlightly porous maſs, hard and refractory. I have not given the ſpecific gravities of the two laſt natures of ſtones: iron-ſtones containing equal portions of iron, in ſimilar ſtates of preparation, vary little in their ſpecific gravities.

It

It will no doubt be obſerved, that the increaſe of weight in theſe ſtatements tally not with the ſums formerly given: the amounts there adduced are reſults from iron-ſtones which had been previouſly deprived of moſt of their oxygen; but in theſe, the extra quantity of oxygen taken up by the ſtone is only given, forming an aggregate, with the original exiſting quantity, as ſhall hereafter be ſhown, nearly correſponding to the ſums firſt given.

From theſe experiments, ſingled out to convey a juſt idea of the changes to which iron-ſtone may be ſubjected, it becomes obvious, that all the varieties of iron-ſtone are capable of decompoſing atmoſpheric air at a certain temperature, and of fixing a portion of its oxygen, whereby weight is gained, by each, nearly equal to 1-8th of its original quantity.

It muſt alſo from this appear obvious, that the burning of iron-ſtone is an operation—though hitherto conducted by chance, expoſed to all weathers—of the greateſt nicety, and conſequence to the certain and economical manufacture of caſt-iron; wherein a ſmall addition of fuel, by exciting a high temperature, expoſes the iron to the combination of a hurtful principle, in quantity (as will hereafter be ſhown) almoſt equal to what the metal was originally precipitated in. The extra proportion of fuel, therefore, requiſite under circumſtances where a ſevere mode of torrefaction is either univerſally adopted, or where it is frequently the reſult of inattention and want of ſkill, though as yet unaſcertained upon a large ſcale, muſt be very conſiderable.

I look upon it therefore to be a great deſideratum in the preparation of iron-ſtone, to contrive a mode which would unite certainty and economy; a mode which would either de-oxygenate the ore unexpoſed to external air, or which would diſſipate its volatile mixtures expoſed to air, with a degree of certainty which, with a ſmall ſhare of attention, would preclude the poſſibility of the metal attracting more oxygen.

In the preſent mode of preparing iron-ſtones, too much is left to chance and the diſcretion of ſubordinate workmen. The ſurface of the piles, being always in contact with the open air, is frequently expoſed to perforations from winds, eſpecially in thoſe parts where the layer of ignited coals comes in contact with the current: a hollow ſpace is ſoon formed; the fuel, by means of the freſh air continually pouring in, becomes ignited to whiteneſs; the ſurrounding ſtone is immediately fuſed: ſhould this aperture be joined by a ſimilar communication from oppoſite ſides of the fire, a degree of heat will be excited beyond what could have been conceived poſſible in this mode of burning, and oxygen be combined with a maſs of ſtone in ſuch an high proportion as to form a very conſiderable part of the whole weight. This is an accident which will take place even where order, regularity and experience are conſpicuous: were it poſſible to avoid it by torrefying the iron-ſtone in that juſt temperature which has been formerly demonſtrated as the moſt proper, uniting at ſame time an equal degree of economy, it would contribute greatly to reduce to certainty and rule the operations of the ſmelting-furnace.

The extreme of fuſing the materials, and combining the iron with an extra portion of oxygen, is not the only evil which an accurate mode of torrefaction would avoid: the ſame train of caſualty often affords a conſiderable portion of the ſtone not enough prepared, and ſome quite untouched by the fire. The effects produced by iron-ſtone in this ſtate are exactly ſimilar to thoſe experienced in the former, ariſing from the ſame cauſe, but exiſting as the reſult of two oppoſite extremes.

I confeſs it is much eaſier to point out the faults of an eſtabliſhed mode of practice, than to ſubſtitute one, which, though it might unite ſome ſuperior advantages, yet might not combine an equal number upon an extended ſcale. I have frequently conſidered the ſubject, and have as often been impreſſed with the truth of its importance in the manufacturing

nufacturing of iron. At ſome future period I may ſubmit to the manufacturers of iron a double method of preparing iron-ſtones for the blaſt-furnace; in which, certainty of operation would be obtained, and in the end moſt probably a degree of economy inſured equal to that of the preſent mode.

I would effect this by expoſing the iron-ſtone ſtratified with a ſmall proportion of coals, in ſimply conſtructed ovens, entirely covered on the top, except a few ſmall funnels to carry off the ſmoke and diſengaged vapours; the ignition to be occaſioned by a current of flame paſſing under a flue in the bottom of the furnace, and conveying combuſtion to the ſub-ſtratified coals. As this operation could be conducted to a phyſical certainty by means of damping the furnace inſtantaneouſly, as ſoon as the vapour, &c. had ceaſed, or as ſoon as complete ignition had pervaded the contents, (the duration to be determined by the nature of the iron-ſtone,) the reſults in this caſe could at all times be depended upon, and the preſent irregular products avoided. A ſecond method of depriving iron-ſtones of their volatile mixtures would be to expoſe them to a conſiderable degree of heat, in contact with the duſt of pit-coal coaks—as being the moſt economical—ſhut up from the admiſſion of external air. This would not only deprive them of their acid water, &c. but would alſo unfix moſt of the oxygen combined with the metal, and afford the iron nearly in a diſengaged ſtate. Both theſe methods, however, at the preſent time, want the ſanction of approving practice, on an extenſive ſcale, to render them uſeful, or worthy of univerſal attention.

De-oxygenation of Iron-ſtones.

This proceſs has been long known in part, and its principles (ſo far as underſtood) applied by the metallurgiſt to deprive the ore, ſubjected to the aſſay-furnace, of its oxygen, in order that the metal might become revived. Its operation is however much more extenſive than what has hitherto

been conceived; and its reſults afford the moſt beautiful and intereſting phenomena known in the art of manufacturing iron.

De-oxygenation in the caſe of iron-ſtones will admit of being divided into three diſtinct ſtages, all of which tend to the ſame final reſult.

1. That wherein iron-ſtone is found to have loſt its water of cryſtalliſation and continuity of fracture; to have aſſumed a greyiſh white colour, ſoft and pulverulent; and greatly ſpecifically lighter than formerly, having loſt from 2-5ths to 9-20ths of its original weight.

2. That ſtage wherein the pieces have aſſumed the ſtate of malleability, and have again become firm and connected; wherein they brighten under the file; and, when ſubjected to the hammer, under various degrees of heat, receive impreſſions at pleaſure, and draw into ſhape.

3. That ſtage wherein, by prolonging cementation, the pieces of iron-ſtone are found to have paſſed into the ſtate of ſteel; poſſeſſing all its properties, though difficult to ſeparate from the earthy parts, and preſerve its quality; but which may be precipitated from the ſteelified ore by fuſion, in the ſtate of caſt-ſteel, by means of the aſſay-furnace.

Theſe three diſtinct ſtages of de-oxygenation are produced by a continuation of the ſame cauſe to which all iron-ſtones may at pleaſure be ſubjected. With primary ores, richer in iron, the reſults are more certain, ponderous, and much better ſuited to operate upon, for the production of good malleable iron and ſteel: theſe are almoſt univerſally capable of being de-oxygenated, for the production of both theſe modifications of the metal. I have met with no exception, indeed, but in the caſe of a few granulated Norwegian ores, a blue ſpeckled Daniſh ore, a few Ruſſian bog ores, and the Scotch ore of the iſland of Iſlay.

In the preſent paper I ſhall confine myſelf to a minute detail of the firſt ſtage of de-oxygenation; the ſecond and third ſtages, as they more immediately belong to the manufacture of

of iron and ſteel, ſhall be fully conſidered in connection with this curious mode of manufacturing theſe ſtates of the metal from ores without fuſion, which, from its novelty and ſimplicity, deſerves a thorough inveſtigation of operation and principle.

De-oxygenation ſimply conſiſts in expoſing iron-ſtone or ore, ſtratified with coaly matter, ſuch as the duſt of pit-coal coaks, or the charcoal of wood unexpoſed to air, at a high temperature. The oxygen contained in the ore is taken up by the charcoal, and paſſed off in the ſtate of carbonic acid; while the water, carbonic acid, &c. previouſly exiſting in the ſtone, is evaporated by the addition of caloric. In proportion as the ore becomes cleared from theſe mixtures, the metal becomes more and more revived, approaching however to the ſtate of malleable iron, though ſtill interſperſed with the original quantity of earthy parts united in the ſtone. By increaſing the temperature, and continuing its duration, the particles of iron unite, and form themſelves into fibres, which, even when cold, may be twiſted and bent a little; ſtill however having the original quantity of earthy matter almoſt inviſibly interpoſed betwixt their interſtices. If the heat is urged ſtill further, the iron, now malleable, begins to take up a portion of the carbon from the charcoal, and the metal then commences its change to ſteel.

During any part of the proceſs, ſhould air come in contact with the ore, by previouſly deſtroying the ſurrounding charcoal, an immediate oxydation of the iron takes effect, proportioned in its increaſe of weight to the ſtage of the operation at which it is effected. The ore has then paſſed into a friable, bulky, and unmetallic ſtate.

In de-oxygenating iron-ſtones, with an intention of diſcovering and of eſtabliſhing an analogy as to the quantity of oxygen contained in the reſpective claſſes of ſtones, I was frequently led to conclude, that argillaceous and calcareous iron-ſtones contained leſs oxygen than iron-ſtones where a

greater proportion of ſilex predominated. Though by far the greater number of experiments performed on this ſubject were in favour of ſuch an inference, yet I have at times experienced my arrangement palpably contradicted, without being able to ſolve the obtruding difficulty. I ſhall not however deſpair, in moſt caſes, to reduce to certain invariable inherent properties, and external characteriſtic forms, the various iron-ſtones in the manner in which I have arranged them, and conſonant to the reſults obtained from them in the proceſs of manufacture. The utility of ſuch an arrangement, founded upon experiment, muſt be obvious and ſtriking: it will give certainty and value to the various products of the manufacturer, as it will in the end ſyſtematize the manufacture itſelf, and reduce it to rules guided by principle, and not by the aberration of a falſe or miſinformed judgment.

From many experiments I have made with all the varieties of iron-ſtones found in this country, I ſhall ſubjoin the treatment of one of each claſs, highly marked with the predominating earths, that an accurate opinion may be formed of the phenomena exhibited in this part of the proceſs.

1. I uſed a fine argillaceous iron-ſtone, in ſmall pieces, weighing - - - - 1750 grs.

After a proper diſtillation of 8 hours in a degree of heat equal to 30° of Wedgewood, I obtained a fine purple-coloured fibrated iron-ſtone, which, when cold, weighed - - - 1160

Loſs of water, acid, and ſulphur, equal to 33·6 per cent. - - - - 590 grs.

The influence which the magnet poſſeſſed over this ſtone was conſiderable; the adheſion to the tongue was however great.

I next introduced into a proper veſſel, in contact with charcoal-

charcoal-duſt, ſome pieces fractured from the ſame original maſs; they alſo weighed - - - 1750 grs.

After expoſure for 14 hours to a degree of heat equal to 120° of Wedgewood, the iron-ſtone, being carefully ſeparated from the charcoal and dried, weighed - - - - 1002

Loſs of water, acid, ſulphur, and oxygen - 748 grs.
Loſt by ſimple diſtillation - - 590

Oxygen taken up by the charcoal, equal to 9 parts in 100 - - - - 158 grs.

This muſt not, however, be taken as the total meaſure of oxygen combined with the iron, but only that portion taken up in the firſt ſtage of the operation; which, as it poſſeſſes the following properties, fully entitles it to this diſtinction:

1. The iron-ſtone, from being firm and compact, poſſeſſing ſpecific gravity from 3 to 3·5, now becomes comparatively light, friable, and pulverulent; ſpecific gravity, from 2·1 to 2·5. It now moulders with a ſlight preſſure, and is eaſily reduced to fine powder of a whitiſh grey colour, which again poſſeſſes the following diſtinct properties: It adheres to the magnet in the greateſt abundance, but not in confuſed cluſters like iron-ſtone ſimply torrefied: a manifeſt indication to become attached in the form of fibres is viſible; and the quantity taken up is equal in point of bulk to the effect produced with iron filings.

2. Iron-ſtone in this ſtate pulveriſed, when ſtrewed in the flame of a fire or candle, gives out metallic ſparks, like the combuſtion of iron-filings when ſtrewed in the ſame manner. When the flame of the blow-pipe is directed upon it, a conſiderable inflammation takes place, and the metallic particles again become oxydated.

3. In this ſtate iron-ſtones poſſeſs the property of effervеſcing violently with the ſulphuric and muriatic acids. The iron and lime are inſtantly diſſolved, without the production of heat. This is only peculiar to iron-ſtones at this

period

period of de-oxygenation. In no other ſtate either raw or roaſted does iron-ſtone poſſeſs this property, unleſs highly united to lime; but remains undiſſolved till it has attracted a portion of the oxygen from the acid with which it is in contact.

From theſe confirming circumſtances I conclude, that the particles of metal exiſt in a highly diſengaged ſtate; that they are partially malleable, yet ſo much combined with oxygen as to be eaſily precipitated, in fuſion, for the production of caſt-iron, with a ſparing proportion of fuel, and a proper application of ſolvents. So far, therefore, as this experiment leads us, the practical analyſis of this ore may be thus ſtated:

In the aſſay-furnace this iron-ſtone yielded a button of ſuper-carbonated crude iron equal to - - 39·5 parts.

Water, carbonic acid, and ſulphur, loſt in ſimple diſtillation - - - - 33·6

Oxygen taken up by the charcoal - 9·0

In the ſubſequent part of the operation I found that, when the iron-ſtone had aſſumed malleability, and brightened under the file, a further quantity of oxygen was taken up, equal to - - - 4·2—13·2

Clay, lime and ſilex united in the ſtone - 13·7

100 parts.

The earths I found to be proportioned nearly as follows: Clay 7 parts, calcareous earth 4, ſilex 2·7 = 13·7.

II. Of a calcareous iron-ſtone, reduced in the ſame manner, I operated upon - - - 1750 grs.

After being expoſed to a ſimilar diſtillation, I found it to weigh - - - 1090

Loſt in water, acid, and ſulphur, equal to 37·7 per cent. - - - - - 660 grs.

This iron-ſtone, when torrefied, exhibited a thin ſchiſtus of

of calcareous plates: its fracture alſo preſented calcareous lines running in various directions: its colour was reddiſh brown, partially fibrated, magnetic, and tenacious to the tongue.

I took of the ſame, mixed with charcoal duſt, 1750 grs. and expoſed the veſſel to a temperature equally high with the former.

The reſidue, when carefully ſeparated from the charcoal, waſhed and dried, weighed - - 922

828 grs.

Loſt in ſimple diſtillation, as formerly ſhewn, 660

Oxygen taken up by the charcoal, equal to 9·6 parts in 100 - - 168 grs.

In this ſtate the ſtone was pulverulent, much frittered, and of a darkiſh grey colour. Its fracture exhibited a number of white ſpots like madrepore. In many places lime was diſtinctly perceived: when pulveriſed, it ſparkled in the flame, diſſolved rapidly in acids with a violent efferveſcence, was leſs magnetic than the former, though poſſeſſing a great tendency to adhere in the form of fibres. From this treatment the practical analyſis of this ſtone will ſtand as follows:

In the aſſay furnace it yielded, of ſuper-carbonated crude iron, - - -		37·5 parts
Water, acid, and ſulphur loſt, as formerly ſhewn, - - -		37·7
Oxygen taken up in the firſt ſtage of de-oxygenation - - -	9·6	
Afterwards taken up in cementing the iron-ſtone to render it malleable - -	4·9	—14·5
Clay, lime and ſilex - - -		10·3
		100 parts

By diſſolution in acids, I found the earthy parts to be nearly as follows: Lime 5·2—Clay 3·1—Silex 2 = 10.3.

This

This analyſis muſt not, however, be taken as a ſtandard whereby the quantity of iron and earth is to be judged of in calcareous iron-ſtones in general. The iron-ſtones of this claſs contain much leſs iron than argillaceous or even ſiliceous iron-ſtones: 28 to 32 per cent. are products more commonly met with than 37 and upwards; the difference in point of metal being made up in lime and clay. In ſtating the quantity of oxygen diſengaged, I conceived it proper to adduce iron-ſtones, though of different claſſes, yet containing nearly the ſame weight of metal as the quantity either diſengaged or abſorbed muſt be in a direct ratio to the exiſting quantity of iron.

III. I operated with a ſiliceous iron-ſtone, weighing alſo - - - - 1750 grs.
compoſed of ſmall pieces, and expoſed for the ſame length of time, and to the ſame degree of heat as the former claſſes: the reſidue weighed - - - - 1249
Loſt in volatile matter by ſimple diſtillation, equal to 28·6 per cent. - - 501

In its preſent ſtate the fracture of this iron-ſtone was reddiſh brown, ſtudded with ſpiculæ of ſhining ſilex, ſlightly adheſive to the tongue, and conſiderably obedient to the magnet.

I next introduced into a crucible, ſtratified with charcoal-duſt, ſome pieces of the ſame maſs, weighing - - - 2374 grs.
and expoſed them to a degree of heat of equal intenſity with the former; after the pieces were waſhed, and carefully dried, they weighed 1343

Amount of water, acid, ſulphur, and oxygen diſſipated - - - 1031 grs.
Equal to - - 43·4 parts in 100
Loſt in ſimple diſtillation as above 28·6

Oxygen taken up - - 14·8

This iron-ſtone was frittered, very magnetic, but diſſolved leſs rapidly in acids, and with leſs effervescence; colour of the fracture light grey, and ſlightly ſpongy. The practical analyſis of this ſiliceous iron-ſtone will therefore ſtand thus:

Carbonated crude iron obtained in the aſſay furnace - - - - -	36	parts.
Water, acid, and a conſiderable portion of ſulphur - - - - -	28·6	
Oxygen taken up as above -	14·8	
Further, as will hereafter be ſhewn in making the iron-ſtone paſs into a ſtate of malleability - -	2·5—17·3	
Earths, viz. ſilex 9, lime 6, clay 3·1, = -	18·1	
	100	parts.

In theſe experiments I wiſhed to obtain reſults which would throw light upon the de-oxygenation of iron-ſtones, with a view to apply them to practice upon an extended ſcale. I therefore uſed freſh ore, in order to preſent nearly the ſame ſurface to the action of the heat, and to be able to judge of the reſults apart from each other. In torrefaction it frequently happens that the ſtone is reduced too ſmall to enable us, by its ſubſequent treatment, to form a probable opinion of the tenacity, or otherwiſe, with which iron-ſtones hold their oxygen. The difference betwixt returning into the crucible the ſame pieces deprived of their volatile mixtures, and operating upon freſh ore, cannot be great, eſpecially when they are ſelected from fragments of the ſame maſs, directed by an intimate acquaintance and thorough knowledge of the qualities indicated by their external forms.

All iron-ſtones thus expoſed to de-oxygenation become more or leſs ſaturated with carbon; it forms a union like carbon in ſteel, and its preſence is only aſcertained when the iron-ſtone is diſſolved in an acid, by riſing to the top, and forming a fine pellicle poſſeſſing luſtre and various ſhades

of

of colour. I have alſo at times detected crude carbon in the centre of pieces of ore $1\frac{1}{2}$ inch diameter. To the remainder of this mixture, after the oxygen is taken up, ought to be attributed the natural tendency which moſt malleable iron made in this proceſs has of becoming red-ſhort.

The average of the reſults of the principal claſſes of iron-ſtones may ſerve for information on the products obtained, by treating thoſe of equal quantities of mixture. The analyſis here furniſhed is not that of the chemiſt, or laboratory; but, though the calculations are leſs rigorous, yet they are ſufficient for the manufacturer, and better ſuited for practical information; as they never once loſe ſight of their application and effects in the large way of manufacture, and as they have been chiefly effected by an agent, which alone, in the large way, can modify the whole, and procure reſults conſonant to the uſe and exiſtence of the metal.

From the amount of the experiments here recorded I would be apt to draw this concluſion, that, in general, iron-ſtones are variouſly combined with oxygen as to quantity: argillaceous iron-ſtone, leaſt; calcareous, more; and ſiliceous iron-ſtones, moſt of all.

In the general arrangement which I have made of iron-ſtones in this and the preceding paper, I wiſh not to be underſtood as having comprehended every variety which may exiſt; new claſſes may be brought to light, as the progreſs of diſcovery and eſtabliſhment advances. I am at preſent, however, acquainted with only one exception, which, from its ſcarcity, I have avoided claſſing along with thoſe generally uſed. My experiments alſo have hitherto been limited as to the nature, ſo that at the preſent time I am only enabled to ſtate a few, of its diſtinguiſhing properties. This iron-ſtone is found near to Clough Iron Works, in the county of Lanark. Its appearance is much like a coarſe ſchiſtous coal; its average thickneſs is about $1\frac{1}{2}$ inch; poſſeſſing a dark ſandy fracture, and by no means reſembling an ore of iron. The mixture is a union of coal and iron

with

with a ſmall proportion of ſilex. Its inflammability is great, and it requires a cautious preparation for the blaſt-furnace. For this purpoſe it is built upon a thin layer of coals, in piles not exceeding 20 inches, or 2 feet: the coals are kindled in the uſual manner, and convey ignition to the incumbent ſtone. Theſe precautions are abſolutely neceſſary, otherwiſe the whole ſtone would be connected in one general maſs by fuſion.

I expoſed of this ſtone to diſtillation - - 979 grs. in a bright red heat for 7 hours, during which time a conſiderable degree of combuſtion took place, and a black vapour was diſengaged; when cool, the reſidue weighed - - - 476

Loſt, of water, bitumen, and carbon, equal to $51\frac{3}{10}$ per cent. - - - - 503 grs.

In this ſtate, the iron-ſtone was divided into thin, blue laminæ, of a vitreous nature, and very weakly magnetic.

I next torreſied, of this ſtone in contact with charcoal-duſt, - - - - - 1163 grs.

When ſeparated, waſhed, and dried, the reſidue weighed - - - - 590

Loſs of mixtures equal to $49\frac{7}{10}$ per cent. - 573 grs.

The charcoal was in part conſumed, and part of the ſurface of the ore expoſed to contact with air, otherwiſe it is probable that the loſs in de-oxygenation would have been leſs, by the quantity of carbon contained in the ſtone, than in torrefying in the open air; where the carbon muſt infallibly be conſumed, and the loſs greater. In this ſtate of de-oxygenation this iron-ſtone poſſeſſes the uſual properties peculiar to the other varieties. At Clough it is highly eſteemed, both as to the quantity and quality of the iron it affords. It is reckoned, in a torrefied ſtate, to yield in the blaſt-furnace from 55 to 60 per cent. This is eaſily accounted for, when it is conſidered, that it loſes more than half its weight in torrefaction.

IV. *A ſhort Account of Souffriere in the Iſland of St. Lucia. From* Obſervations on the Diſeaſes which appeared in the Army there in December 1778, &c. *By* Dr. ROLLO.

HAVING in our Number for Feb. laid before our readers an account of the volcano in the iſland of St. Lucia, from the Swediſh Tranſactions, the following particulars reſpecting it and the neighbourhood are now inſerted, as they tend to make the deſcription of that ſingular ſpot more complete.

"Souffriere is a ſmall town ſituated at the bottom of a bay towards the leeward extremity of the iſland. It is ſurrounded by hills covered with trees, the declivities of which, and every part capable of produce, are cultivated, and afford good ſugar-cane. This place has its marſhes, but not ſo extenſive, or ſo much to windward as thoſe about Carenage.

"The extremity of the ſouth ſide of Souffriere Bay runs into two ſteep hills of a conical figure, which are nearly perpendicular: they are reckoned the higheſt on the iſland, and are known by the name of the Sugar-Loaf Hills. From their height and ſtraitneſs it is impoſſible to aſcend them: we were told it was once attempted by two negroes, but they never returned. They are covered with trees and ſhrubs, and are the ſhelter of goats, ſeveral of which ſometimes deſcend, and are ſhot by the natives.

"After you paſs the hills to windward of Souffriere, a fine, clear and level country preſents itſelf. From the back of the Sugar-Loaf Hills, and all along the ſea-coaſt, to the diſtance, we ſuppoſe, of from fifteen to twenty miles, this flat or level extends: it is all cultivated and divided into rich eſtates, affording ſugar-cane equal to any in our iſlands. This beautiful ſpot is interſected by many rivers of very clear water, and theſe are conducted by art to the purpoſe of ſugar-making. The rains in this part are leſs frequent than on any other part of the iſland; however, they have often a

proportion more than ſufficient. The wind here blows from the ſea, or nearly ſo.

"We cannot finiſh this deſcription without taking notice of a volcano in the neighbourhood of Souffriere. You paſs over one or two ſmall hills to the ſouthward of the town, and, before any mark of the place is perceived, you are ſenſible of the ſmell of ſulphur. The firſt thing you diſcern is a rivulet of black running water, ſending forth ſteams as if nearly boiling. From the proſpect of this you ſoon open on the volcano, which appears in a hollow, ſurrounded cloſe on every ſide by hills. There are only two openings; the one we entered, and another almoſt oppoſite to it on the north ſide. In the hollow there are many pits of a black and thick boiling matter, which ſeems to work with great force. Lava is ſlowly thrown out; and in the centre of the hollow there is a large maſs of it, forming a kind of hill. This we aſcended; but were ſoon obliged to return, from the exceſſive heat. The lava is a ſulphur mixed with a calcareous earth and ſome ſaline body. We found ſmall quantities of alum in a perfect ſtate. In the opening, at the north ſide of the hollow, there is a rivulet of very good water. On ſtirring the bottom, over which this water runs, we were ſurpriſed with feeling it very hot; and on placing a tumbler filled with ſome of the water cloſe to the bottom of the rivulet, it ſoon became ſo hot as not to be touched. The liquid which runs from the pits is ſtrongly impregnated with ſulphur, and reſembles a good deal the preparation ſold in the ſhops, known by the name of *aqua ſulphurata*, or *gas ſulphuris*. Before St. Lucia was in our poſſeſſion, two or three veſſels were loaded with the crude ſulphur of this volcano, for the uſe of America."

V. *Extract of a Report, on the Means to be uſed for purifying the Air in the Apartments of Sick Perſons, made to the Society of Medicine at Bruſſels.* *By* J. B. Van Mons.

THE principal object of the author, in this Report, is to prove that it ought not invariably to be the aim of the phyſician to repair the loſs of a portion of the reſpirable air in the atmoſphere which ſurrounds the patient; ſince diſeaſes may occur, ſuch as thoſe of a putrid and inflammatory nature, where an augmentation of the unreſpirable part may be beneficial. In ſuch diſeaſes, if air of the common ſtandard be reſpired, the patient is furniſhed with ſuch a portion of oxygen as, by increaſing animal heat and accelerating circulation, muſt naturally increaſe the fever, inflammation and putrefaction, or decompoſition of the blood and other humours. A lowered atmoſphere, which in health is improper for reſpiration, muſt in theſe ſtates prove ſalutary, as, by affording leſs oxygen to the ſyſtem, it will abate inflammation, check the putrefaction, and diminiſh other bad ſymptoms, producing the good effect of what are called cooling medicines. Theſe principles are confirmed beyond a doubt by daily experience *.

"It is," ſays this author, "to the ſalutary effect produced by diffuſing through the atmoſphere a new portion of unreſpirable and of diminiſhing the reſpirable air that fumigations have been ſo long indebted for their being employed as correctors of corrupted air, while thoſe who preſcribed them often did ſo on a very contrary ſuppoſition.

"In general I have found the air in the apartments of ſick perſons to conſiſt of abundance of carbonic acid gas, hydrogen gas, oxygen gas, and azotic gas; ſometimes of a

* No facts of this kind are known in England; and from the experience of Dr. Thornton and others, it would ſeem, that a ſuper-oxygenated air is highly beneficial in putrid diſeaſes, although it be inimical to thoſe of an inflammatory nature. Edit.

little

little ammoniacal gas, and a peculiar emanation called contagious miaſm, which appears to be a particular combination of hydrogenous carbonic acid gas, holding in ſolution animal fluids as yet little known. Hydrogen gas almoſt always holds in ſolution pure carbon, phoſphorus, &c. from which ariſes the ſmell of theſe gaſes, often ſo diſagreeable. Carbonic acid gas would form a much more conſiderable part of the atmoſphere which ſurrounds ſick perſons, were not this gas continually neutraliſed and rendered concrete by the ammonia, which is formed and evolved in all diſeaſes where animal ſubſtances containing azot are decompoſed. It may readily be perceived into what contradiction thoſe have fallen who ſuppoſe air to contain at the ſame time carbonic and ammoniacal gas. The abſurdity of expoſing in the apartments of the ſick, veſſels filled with quick-lime, muſt alſo be obvious; the inconvenience of which, in all caſes, is to leave in a diſengaged ſtate, or to return to the air, the ammoniacal gas; the carbonic acid gas, which would otherwiſe neutraliſe it, being taken up by the ſtronger affinity exerted upon it by the lime; and, in ſome caſes, to take away an unreſpirable gas, the preſence of which would be beneficial.

"I have aſcertained that in a ſtate of health we form by reſpiration more water, and in a ſtate of diſeaſe more carbonic acid. The carbon ſeems, at a certain temperature, to exerciſe on the oxygen a ſtronger attraction than the hydrogen can in the ſame temperature. Among the principal means for purifying infected air I claſs vaporiſed water, which incommodes the patient very little, and takes putrid emanations out of circulation better than the muriatic and acetous acids, or than ſpirits, being a better ſolvent than theſe liquids. When the air is ſurcharged with ammonia, I would rather let looſe into it the carbonic acid gas than the acetous or any other acid. The caſe in which C. Guyton employed with ſo much ſucceſs the muriatic acid vapours

was totally different from thoſe which have been the objects of my reſearches.

The ſulphurous acid gas would be uſeful in ſome caſes to decompoſe miaſmata, by giving up to them a portion of its oxygen; but it leaves behind it an oxyd of ſulphur, the ſmell of which is extremely offenſive: the oxygenated muriatic acid gas ought therefore to be preferred.

The gaſes which in my opinion ought to be employed for augmenting the portion of unreſpirable air, are the carbonic acid gas and hydrogen gas. The firſt ought to be made to paſs through water, and the ſecond through oil. By theſe means you free the carbonic acid gas from that portion of the acid employed to diſengage it from the carbonat uſed, which it carries along with it; and you precipitate from the hydrogen gas the carbon it holds in ſolution. The oil, after being uſed ſome time for this purpoſe, is found quite black, and converted into empyreumatic or carbonated oil.

VI. *Simple and Eaſy Method of Cleaning and Whitening Prints or Engravings. By* M. Fabbroni. *From* Annali di Chimica, *by* Brugnatelli. *Vol. XIV.*

THE methods formerly employed for cleaning engravings conſiſted in waſhing them in pure water, or a weak lixivium of pot-aſh, or in expoſing them a very long time to the dew. Aquafortis has alſo been ſometimes employed. Leys, however, together with the dirt and filth, carried away part of the colour of the engraving, and aquafortis attacked the vegetable fibre of which the paper of the print was compoſed.

Since the diſcovery of the oxygenated muriatic acid by Scheele, and the application of its properties, by Berthollet, to the bleaching of cloth, trials have been made of it alſo for whitening prints and engravings; and Chaptal's experiments on this ſubject were attended with the beſt ſucceſs *.

* For Chaptal's proceſs ſee Phil. Mag. Vol. II. p. 28.

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This proceſs, however, is not ſo generally followed as it ought to be, chiefly becauſe the preparation of the oxygenated muriatic acid is attended with more trouble than ſome people will take, and becauſe it is ſometimes difficult to procure the acid ready made. This conſideration induced M. Fabbroni to make known the following proceſs, which is extremely eaſy, and may be put in practice by any one.

Half fill a glaſs bottle with a mixture compoſed of 1 part of the red oxyd of lead, or minium, and 3 parts of the muriatic acid; and having cloſed the mouth of the bottle with a glaſs ſtopper, put it in a cool place, not expoſed to the light. A certain heat will then be produced, which is an indication that new combinations are formed. The oxyd of the lead abandons a conſiderable portion of its oxygen, which remains combined with the liquor *; the latter then acquires a beautiful gold colour, and aſſumes the odour of the oxygenated muriatic acid. It holds in ſolution a ſmall portion of the lead, which does not in the leaſt injure its effect †. It is neceſſary that the bottle ſhould be of ſtrong glaſs, and that the ſtopper be well ſecured, in order to prevent the elaſtic vapour which riſes from forcing it out. When you employ the liquor thus prepared, take a large pane of glaſs, and raiſe a kind of border of white wax around its edge, about two inches in height, and every where equal. By theſe means you form a ſort of trough, into which put the prints, and pour over them a little freſh urine, or water mixed with a portion of ox-gall. At the end of three or four

* Where the oximuriat of pot-aſh can be had, the proceſs recommended by Mr. Cruickſhank, of Woolwich Hoſpital, will be found neater than the one here propoſed. If the oxygenated muriat of pot-aſh be ſimply added to the muriatic acid, diluted with about an equal bulk of water, the ſalt is ſlowly decompoſed, and the acid converted into the oxygenated acid. About 1 drachm of the ſalt, if pure, is found to be ſufficient for three ounces of the dilute acid. EDIT.

† If this be a fact, the portion of lead held in ſolution muſt be ſmall indeed—otherwiſe it ſhould be partially revived in a length of time, and produce blackneſs. EDIT.

days pour off whichever of theſe liquids you have employed, and ſupply its place with warm water, which ought to be changed every three or four hours, until it come off perfectly clear. When the matter with which the prints are dirtied is of a reſinous nature, which ſometimes happens, dip them in a little alcohol: afterwards ſuffer all the moiſture to drain off, and cover the prints with the liquor of the oxygenated muriatic acid made by minium. Place on the edges of the wax another pane of glaſs, of the ſame ſize as that below, in order that you may not be too much incommoded by the ſmell of the acid; and you will then plainly ſee the yelloweſt prints reſume their original whiteneſs. One or two hours will be ſufficient to produce the deſired effect. Having then poured off the acid, waſh the prints, ſeveral times, in pure water, and dry them in the ſun.

VII. *Obſervations on the Britiſh Trade with Turkey. From* Eton's Survey of the Turkiſh Empire.

FORMERLY the trade to Turkey was of conſiderable importance to this country; but of late years it had been languiſhing, and at laſt dwindled into a ſtate of inſignificancy, when the preſent war entirely put a ſtop to all communication with the ports of the Levant.

As this trade will be again opened when a peace takes place, an inveſtigation of the cauſes of its decline, and the means to give it its ancient extenſion, may not, in the mean time, be unimportant to the government and to the merchants of this country.

The cauſes of its gradual decline are, 1ſt, The rivalſhip of other European nations; 2dly, The diminution of the conſumption of our manufactures in Turkey, by the impoveriſhed ſtate of the country; 3dly, Some branches of trade being got into other channels; and 4thly, The monopoly of the Levant Company in London.

With reſpect to the rivalſhip of other nations, that cauſe will be conſidered when I ſpeak of the Levant Company. As to the impoveriſhed ſtate of Turkey, it muſt affect the trade of other European nations as well as our own; if we are not, therefore, to expect to ſee it again in that flouriſhing ſtate in which it was, when there were forty Engliſh houſes of trade at Aleppo, (at preſent there is but one,) we may at-leaſt expect to have the ſame proportion of it as we then had; and if we acquire only this, our trade to the Levant will ſtill be a national object. Some branches of trade are got into other channels; this regards principally certain imports from Turkey, and particularly of ſilk from Aleppo, whence formerly larger quantities of Perſian ſilk came, which is not now brought thither, but the Eaſt India Company ſupply our market cheaper and more abundantly. Conſiderable quantities of cotton and drugs come from Holland and from Italy, which formerly came direct. This will alſo be accounted for in the next conſideration, the monopoly of the Levant Company.

It is often neceſſary, and where merchants undertake to open to the country a new branch of trade, and where the expence and riſk is great, it is juſt, to grant them excluſive privileges, or monopolies, for a certain limited time, to prevent others from reaping the harveſt they had ſown, and to ſecure their laudable induſtry as far as poſſible from riſk; but when that riſk exiſts no more, and when they have reaped their harveſt over and over again, and have had a full compenſation for their riſk, their induſtry, and their expence, the country at large has a right to a participation of the trade. There may, indeed, ſometimes exiſt circumſtances of a peculiar nature, which give them a claim to a longer indulgence in their monopoly, particularly where that monopoly is no injurious, but, on the contrary, beneficial to the country in general, (and ſuch is the caſe of the Eaſt India Company;) but in a trade where the merchants have no common ſtock, and can urge none of the above reaſons in defence of their

monopoly; where they cannot prove that any particular loſs would accrue to them by aboliſhing it; where it has operated as a reſtraint on the trade, confining it to narrow bounds, and giving a decided ſuperiority to their rivals of other nations, to the almoſt total excluſion of the products and manufactures of their country from that to which their privilege excluſively permits them to trade, ought in common ſenſe ſuch a monopoly to exiſt? The Levant Company is truly become the *dog in the manger*; it does not operate ſo much to the profit of the company, as to the loſs of the country.

This monopoly is of a ſingular nature: it has none of the advantages of a common ſtock, in which many individuals riſk ſmall ſums, but which in the aggregate amount to a larger capital than any one merchant or ſet of merchants poſſeſs, or would chooſe to riſk; a common ſtock to which any one may contribute, and which thereby, ſtrictly ſpeaking, ceaſes to be a monopoly: it is a privilege granted to certain perſons only to trade to Turkey, each with his own capital, and for his own particular account and riſk, without any aſſignable reaſon why they ſhould be preferred to others his majeſty's ſubjects: it has all the diſadvantages of other monopolies; it has not one of their advantages.

In ſpeaking thus freely of the company, I ſolemnly declare that I have no private motive, no rancour againſt any individual, and no inducement for writing on this ſubject but the advantage of the country. The few members of the company with whom I am acquainted I perſonally reſpect and highly eſteem: on this ſubject they muſt differ with me; they are bound by oath to ſupport the intereſts of their body.

The trade of all other nations to Turkey is free, and they have experienced the advantage of being liberated from the fetters of excluſive privileges. Let every obſtacle be removed in this country to an equally free commerce, and the ſuperior induſtry, ſkill, and riches of our manufacturers, our

traders,

traders, and our navigators, will again reſtore to us our loſt Turkey trade.

It may be ſaid, that at preſent the Levant Company is not a monopoly, as any one, by paying twenty pounds, may become a member of it. When the trade was already ruined, it was imagined that this regulation was equivalent to laying the trade open, (a proof that government have thought it neceſſary to aboliſh the monopoly;) but the bye-laws of the company, and the power to enforce them, were permitted to exiſt, and theſe ſo fetter the trade to new adventurers, that few have found their account in purſuing it, and the trade ſtill remains a monopoly in favour of the old houſes.

It will be neceſſary to paſs in review theſe bye-laws, which have operated ſo injuriouſly to the trade in general; and to ſhow how they have gradually effected its total ruin, and the introduction of rivals, who have gotten poſſeſſion of what we have loſt.

By one of the bye-laws, for inſtance, it was enacted, that all merchandiſe brought from Turkey, and imported into England, ſhould be the produce of goods exported from England to Turkey. The following are the words of the bye-law:

"That upon entering goods received in England from Turkey or Egypt, every member ſhall in like manner ſubſcribe the following affirmation; *videlicet:*

"I affirm, by the oath I have taken to the Levant Company, that the goods above mentioned are for account of myſelf, or others free of the ſaid company, or of ſuch as now have their licence to trade, and are beyond the ſeas; and that the ſaid goods, nor any part of them, are not, to the beſt of my knowledge, the produce of gold or ſilver, either in coin or bullion, ſent into Turkey; but that the ſaid goods are purchaſed by merchandiſe, or monies ariſing or to ariſe from the ſale of merchandiſe ſent into Turkey or Egypt, from Europe, or from the Britiſh ſettlements in America, on account of freemen of the Levant Company, or ſuch as have their licence to trade, and of which regular entries have been

made with the company, or are purchaſed by freight received in Turkey or Egypt, by ſhips navigated according to law; which freight is entirely the property of members of the company, or ſuch as have their licence to trade."

And every merchant or factor in Turkey or Egypt is required to make a ſimilar affidavit, on exporting goods from Turkey for England; and to give, on oath, an exact account of every kind of tranſaction or buſineſs, direct and indirect; ſo that all his affairs become known.

The object of this law is evidently to encourage the exportation of cloth; and when we had no rivals, it produced no bad effects; but it ſoon produced rivals, and it continued in force till they had nearly got poſſeſſion of the whole cloth trade. Such a law, indeed, was ſufficient to ruin any trade. One houſe may deal in exports, another in imports; one may combine its Italian with its Turkey trade; another may ſend veſſels for the carrying trade: but if every individual houſe be obliged to keep an exact regiſter on oath, and under a penalty of 20 per cent. called "a broke," of all its exports and imports, and to balance them exactly, how is ſuch a trade to proſper, where the profits are reduced by the rivalſhip of foreign nations? This bye-law at length, when it had produced the full effect of its ill tendency, was repealed; but the trade was not revived: ſo difficult is it to turn back commerce from channels into which it has run.

It will be aſked, then, what are the reſtraints which now lie on the trade?

The ſubjection to the control of the company; the neceſſity of making entries with it of all their tranſactions on oath, and not being able to be concerned in anywiſe with others not free of the company, or foreigners; the power in the company, for the leaſt violation of their rules, to inflict a penalty of 20 per cent.; the idea of reſtraint, and the apprehenſion of violating a ſolemn oath, have made many determine to trade with Turkey through foreign and circuitous channels, without becoming free of the company: witneſs

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the very large quantities of cottons and drugs, &c. which come from Holland and Italy, as the cuſtom-houſe books prove. This was the caſe till our trade to Holland and the Mediterranean was ſtopped by the war, and in that ſame ſituation we ſhall be when a peace takes place.

The drugs, &c. which are imported from Italy, were carried thither from Turkey; they had already given a profit to the Italian factor in Turkey; to the importer, and to the purchaſer in Italy, who cleans, aſſorts, repacks, and often adulterates them; to the commiſſioner, who purchaſes them for his correſpondent in England; to which add charges, and intereſt of money for ſo long a diſburſement, which the different people through whoſe hands the merchandiſe has gone have all calculated, as well as their profits, double freights, and loading and unloading, &c. &c.

Cottons are imported from Holland, becauſe the company cannot import themſelves enough for the conſumption; and the reaſon why they do not is, becauſe the old members, who are under no apprehenſions of the bye-laws, find other articles enow to employ their whole capital, and beyond that the trade cannot increaſe. This is the reaſon, as will be ſeen hereafter more fully, why the trade in exports as well as imports is confined within ſuch narrow bounds.

The Britiſh merchants in Italy and other foreign countries, not being members of the company, (and to become free of the company they muſt come to England,) cannot trade with Britiſh houſes in Turkey; and theſe, if they will trade to Italy, muſt trade with foreigners: thus all combinations of the trades are prevented. Engliſh veſſels in the Mediterranean might often make a voyage to Turkey, inſtead of lying in an Italian port, and return time enough to take in their cargoes for England.

The great preference given to Britiſh veſſels in the Mediterranean would aſſure them an employment whenever they want freights. This carrying or caravan trade is ſo extenſive,

that,

that, beſides the French, the little ſtate of Raguſa has no leſs than 400 veſſels in it.

Were the maſters of ſhips, their owners, and the Engliſh merchants in Italy and Turkey, under no reſtraint in regard to the Levant Company, people would riſk more readily the ſending their veſſels to the Mediterranean to get employment in this carrying buſineſs, and, their ſpeculation in trade being free, they would find means to employ their veſſels in the intervals of their being without freights; the maſters, owners, and correſpondents might combine their own ſpeculations in merchandiſe with their carrying buſineſs, and thus keep them conſtantly employed. It is the want of theſe reſources to our ſhips, that prevents Engliſh owners from ſending their ſhips into the Mediterranean to ſeek freights, and prevents the few which do go thither from profiting ſo much by it as thoſe of other nations, whoſe houſes of trade are nearer, and whoſe trade is under no reſtrictions.

Had the Turkey trade in England never been a monopoly, the French would never have got poſſeſſion of almoſt all the cloth trade; and the laying it open will be the only means of our coming in again for any conſiderable ſhare in it. There is a greater demand in Turkey for the light Languedoc cloths, than for any other ſort. The Turks clothe their ſervants twice a year; and the French cloth, made into looſe garments, (which laſt much longer than the tight European dreſs,) is ſtrong enough for their purpoſe, and its cheapneſs cauſes it to be preferred; poorer people, who form the great body of conſumers, buy it alſo for œconomical reaſons. Engliſh broad cloth, called mahoot, (of a light quality, made purpoſely for the Turkey market,) is only worn by thoſe in eaſier circumſtances. Conſiderable quantities of cloth have alſo of late years come to Turkey from Germany.

It is the opinion of many people well acquainted with theſe matters, that the Engliſh manufacturers might make the ſame ſort of cloth as the Languedoc, and as cheap as the French;

French; but, as long as the Levant Company exiſts, who is to undertake it? Were the trade laid entirely open, it is probable that all kinds of Engliſh manufacturers would ſend people (called riders) to Turkey to ſeek for commiſſions, as they do to all parts of Europe. This practice, though not very agreeable to Engliſh merchants, (which however may not be the caſe in Turkey, as they may find the mediation of merchants neceſſary,) would greatly increaſe the vent of Engliſh commodities, and theſe induſtrious people might poſſibly be the means of our regaining the cloth trade.

The few merchants who are in the true ſecret of the Levant trade, can employ in it their whole capital advantageouſly, and therefore do not ſeek for new branches, or how to recover old ones which are loſt.—This is the great ſecret.

The French do not get their wool cheaper than we do; the price of labour may be leſs; but will not ſuperior ſkill and induſtry, with larger capitals, compenſate this ſingle circumſtance againſt us? Experience in other articles ſhews it, as in the manufactures of Mancheſter, Sheffield, and Birmingham.

It is very worthy of attention, that the French cannot make ſo cheap as we can the ſame kinds of cloth, which our people bring to the Turkey market; it is not that they cannot make them ſo fine, for they make in France much finer cloth than that kind of broad cloth made in England purpoſely for the Turkey market. There is alſo a coarſe ſtrong cloth brought to Turkey from England, called *londras:* theſe the French cannot make ſo cheap neither; nor are their ſhalloons ſo cheap. In ſhort, there is no ſort of woollen ſtuff made in the two countries, of the ſame quality, which the Engliſh do not ſell cheaper than the French. The fact ſeems to be, that the French invented a kind of cloth more proper for the general conſumption of Turkey than that which the Engliſh had brought thither; and the Engliſh never attempted to follow their example, but continued carrying

rying to the market a ſort of cloth, which at laſt got almoſt out of uſe. Whenever the Engliſh ſhall have made and brought to Turkey the ſame kind of cloth as the French, and cannot afford it ſo cheap, then with certainty we may conclude that the French have an advantage over us; but till then it ought to be doubted, and certainly it merits the trial; but a fair trial never can be made till the Levant trade is entirely free.

But even ſuppoſing that we cannot regain the cloth trade, there are very many other objects worth attending to, and which may be of great national advantage.

The Mancheſter ſtuffs would find a great vent in all parts of Turkey. The manufactories of Aleppo and Damaſcus are almoſt ruined; and if the Mancheſter people were to imitate the Turkiſh patterns of their ſtuffs, they could certainly afford them cheaper. Imitations of the Surat and Bengal goods of ſilk and cotton, which are enormouſly dear, would find alſo a ready ſale in Turkey; and cotton velvets, velverets, &c. Birmingham and Sheffield wares would be articles of importance. The Turks, both in Europe and Aſia, have a great partiality for all theſe kinds of Engliſh manufactures, and in general the epithet Engliſh is ſynonimous with excellent.

Theſe articles at preſent are not attended to; but the maſters of ſhips, who bring out their little ventures to Turkey in a contraband manner, in theſe kind of things, make great profits; they can, however, bring only ſmall quantities, leſt the Levant Company ſhould take umbrage at it. A few of theſe goods alſo find their way to Turkey from Italy, but greatly enhanced in their price from the many hands they go through, and therefore this channel does not afford a great vent for them. Linen may likewiſe be an article of exportation for Turkey. The Turks wear linen of a hard twiſted thread, very open and unbleached, which comes moſtly from Egypt, and is exceedingly dear, but is the moſt pleaſant kind to wear in hot weather. No European nation

has

has yet undertaken to imitate it; but it is probable it might be made in Ireland infinitely cheaper than in Egypt: if this was the caſe, it would be of great importance. The German linens begin to be ſold in conſiderable quantities in Turkey; but they never will ſupply the place of the Egyptian, on account of their quality. Vaſt quantities of the above mentioned articles come from Venice and Germany, where they are dearer, and of worſe quality, than thoſe manufactured in England.

Were I to enter into an enumeration of all the Engliſh manufactures that could be ſold in Turkey, and particularly in the interior parts of Aſia, and point out the different ports to which they might be ſent, the detail would be too long for a general repreſentation; but collectively it muſt be very obvious to every perſon acquainted but generally with the trade of Turkey, that our exportations to that country muſt become of great importance in a few years, were the monopoly removed, and the agents of the manufacturers ſent to travel through the country, and get certain information of the ſtate of its trade and manufactories.

Salt fiſh, could the Newfoundland ſhips, &c. go directly to Turkey as they go to Italy, would be a very important branch.

The Eaſt India Company could ſupply the Turkey market with muſlins much cheaper than they are brought by the way of Baſſora, of Gidda, and Suez, which trade is entirely in the hands of their ſervants: the trial has been ſucceſsfully made; but the members of the Levant Company have other articles enow in which to inveſt their whole capitals. Other nations now bring large quantities of muſlins to Turkey. Britiſh muſlins (*i. e.* manufactured in Britain) alſo ſell to conſiderable profit.

Let all this be mere ſuppoſition, is not the object of importance enough to give it a fair trial? and does not common ſenſe ſay, that a trade freed from obſtacles muſt flouriſh more than when clogged with the moſt unſupportable ſhackles, or

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with any ſhackles at all? May it not be aſked, what juſt right have the members of the Levant Company to lay reſtraints on this trade by their bye-laws? I have heard this ſubject diſcuſſed in Turkey, where people certainly underſtand the trade of the country better than in England, and I never heard one plauſible reaſon alleged in favour of the company. Sophiſtical arguments may be produced in London, which may appear plauſible to thoſe who are not informed of the real ſtate of matters in Turkey.

To ſhow what little efforts have been made by the company to extend the trade, and how little they deviate from the footſteps of their forefathers, I will cite two ſtriking inſtances:

Mr. John Humphrys, of Conſtantinople, was the firſt, who, a few years ago, imagined that Engliſh ſhalloons might be ſold in Conſtantinople, and they ſoon became a very important article for exportation to Turkey. The French have not been able to make them ſo cheap.

Mr. Peter Took, of Conſtantinople, only about twenty years ago, diſcovered that he might buy raw ſilk from the firſt hands at Bruſa, (the hills behind this city are viſible from our merchants houſes in Pera,) and thus make his returns direct to England. Before that period, from the firſt exiſtence of the company, the merchants of Conſtantinople had always ſent their money to Smyrna to be inveſted in ſilk, which the Turks and Jews of Smyrna bought at Bruſa.

There is a great demand in Turkey for Staffordſhire earthen-ware, which would become a very important article of commerce.

Perhaps the greateſt importation of Britiſh articles into Turkey would be by foreigners, or natives of the Turkiſh provinces, as is the caſe in many branches of our commerce, where ſuch reſtraints on foreigners do not exiſt; for inſtance, every one knows that not one-tenth part of our exports to Ruſſia are on account of the Ruſſia Company in London, or of the Britiſh Factory in Ruſſia. Theſe articles are ſent to

Ruſſia

Ruſſia for account of foreigners ſettled in Ruſſia, or Ruſſians, and ſome part for account of our manufacturers. With reſpect to Germany this is ſtill more the caſe.

The Levant Company exact a duty on all merchandiſe exported to and imported from Turkey, beſides a conſulage in the ports of Turkey on all the exports and imports in Britiſh veſſels. This conſulage is a very heavy burthen on our trade, and particularly when it is conſidered that ſome other nations pay none. The following are the words of the company's bye-law:

"At a general court, &c. the following orders were eſtabliſhed as proper and expedient for the ſupport of the company's affairs, and for the government of the trade; and they were confirmed at a general court held 3d of March 1775.

"It was reſolved and ordered, That all goods exported from Turkey or Egypt for Great Britain ſhall pay three conſulages and one-half, or ſeven in the hundred, according to the rates of the company's tarif, in ſuch ſpecies of the grand ſeignior's coin as his officers receive for cuſtoms; which conſulage ſhall be paid, one-half in thirty days, and the other half in ſixty days after the departure of the ſhip, &c.; and the company's treaſurers are not to take any notes or obligations for the payments of conſulages, but they are to inſiſt upon being paid in money when it is due.

"That all goods imported, &c. into Great Britain, ſhall pay one impoſition according to the company's rates, &c. except cotton and emery ſtones, &c.

"That all goods imported into Turkey or Egypt, from Leghorn, or any other port or ports of Chriſtendom, by Britiſh ſubjects or Britiſh ſhips, for account of foreigners, ſhall pay a conſulage of two in the hundred, &c.

"That all goods exported from Conſtantinople, Smyrna, and Aleppo, to Leghorn, or any other foreign port or ports of Chriſtendom, by Britiſh ſubjects, on foreign ſhips, on ac-

count of Britiſh ſubjects, ſhall pay a conſulage of one in the hundred, &c.

"That all goods imported into Turkey or Egypt, by ſtrangers, upon Britiſh ſhips, from any foreign port, &c. ſhall pay two in the hundred, &c. and in like manner exported, two in the hundred, &c." and ſeveral other regulations for the paying of conſulage, of leſſer importance, which I omit for brevity.

"April 29th, 1785. It is reſolved and ordered, &c.

"That all goods, excepting raw ſilk, mohair yarn, and drugs, exported from Turkey and Egypt, in the time of the plague, to Malta, Ancona, Venice, Meſſina, Leghorn, Genoa, or Marſeilles, for the purpoſe of performing quarantine, and which are to be re-ſhipped on the ſame ſhip for Great Britain or Ireland, ſhall pay a conſulage of two in the hundred only."

Beſides this revenue, the company have for many years received an aſſiſtance from government of five thouſand pounds a year. All theſe ſums are expended for paying a part of the ſalary of the ambaſſadors at Conſtantinople, the conſuls at the ſeveral ports in Turkey, the chancellors and drogomans (or interpreters), and for defraying the expences attending viſits from the ambaſſador to the porte, and of the conſuls to paſhas, beſides extraordinary preſents made at the firſt audience of a new ambaſſador and of a conſul; for paying avanias (or money extorted by falſe accuſations), and public entries of conſuls, which were formerly very coſtly; and finally, for the expences of the company and its officers at home.

Were our trade put on the ſame footing as the Ruſſian, the five thouſand pounds government now pays, would perhaps more than ſuffice for all the expences which then would be neceſſary; and that our trade could be put on the ſame footing, I ſuppoſe nobody will deny. The Ruſſian trade to Turkey is free to every one; there is no tax on it, either under

under the appellation of conſulſhip or otherwiſe; no fee is taken at any ambaſſador's, conſul's, or chancellor's office, for documents neceſſary for the diſpatch of trade; no preſents are made by conſuls to paſhas or other officers; no avania is ſubmitted to.

A conſul at Smyrna only is neceſſary. Vice-conſuls in the other ports would anſwer every purpoſe for the protection of trade; and there would be found merchants enow, who would be glad of the office without pay, for the honour of it, which in Turkey is conſiderable. There is at this day no neceſſity for conſuls living in ſuch great ſtate as they did a few years ago. The foreign miniſters at Conſtantinople have very conſiderably retrenched their expences.

The power of an ambaſſador and of a conſul in Turkey is very great; it extends even to life and death. By one of the articles of the capitulations (or treaty with the porte) it is ſtipulated, that in all criminal caſes wherein ſubjects of the porte are not concerned, ambaſſadors or conſuls ſhall puniſh the criminal according to the laws of their country. In the Dutch capitulations this is expreſſed ſtill ſtronger. As crimes committed in a ſtate are crimes immediately againſt that ſtate, the cognizance of them belongs to it alone. The ſultan delegates his power to the ambaſſadors and conſuls; and if in puniſhing the criminal they exceed the rule preſcribed by the laws of their own country, they are only anſwerable for their conduct to the ſultan; but the ſultan takes no cognizance of it, therefore they are without control, and their power is deſpotic. It is indeed true, that they generally ſend ſuch offenders home to their country; there have, however, with other nations, been examples where an European has killed a ſubject of the porte, and juſtice being demanded the ambaſſador or conſul has put the criminal to death. Should it happen that an Engliſhman killed a Turk, it would certainly be better that the ambaſſador or conſul ſhould cauſe him to be hanged by his own people, than that he ſhould deliver him up to the Turks, for juſtice being demanded,

there is no other alternative; if he eſcaped, the conſequence might be a general maſſacre; we have lately had an example at Smyrna exactly of this nature, which coſt the lives of many hundreds, and cauſed the European quarter to be reduced to aſhes. There is no poſſibility of ſending the criminal home if the populace demand juſtice.

The company have given alſo another power to the ambaſſadors and conſuls over merchants, which free traders may not approve of. Their bye-law is: "If any factor or factors ſhall have any dealings with any perſon battulated by the lord ambaſſador, or the conſul of any of the ſcales (ports, Scala Italian) in Turkey, with the advice of the reſpective factories, ſuch factor or factors ſhall pay a fine for every offence to the amount of three conſulages upon the value of the tranſaction by or with ſuch battulated perſon, without appeal, &c." Battulation with them ſignifies interdiction of all commerce with the perſon battulated. The intention was to prevent the factors or merchants having dealings with litigious perſons of the country; but this power has been abuſed.

The ambaſſador formerly had a conſiderable revenue from protections granted to ſubjects of the porte, under the title of Baratli, or honorary drogomans; but theſe protections having been totally diſregarded by the preſent ſultan, who without any ceremony has beheaded ſeveral perſons poſſeſſed of them, both that income and that ſource of conſtant litigation with the porte are partly done away. It were to be wiſhed that this privilege was wholly aboliſhed. The French ſeveral times propoſed giving it up, and at a time when it was reſpected, and lucrative to their ambaſſadors.

The French alſo, on the repreſentation of their ambaſſador, M. de St. Prieſte, laid the Levant trade open; the conſequence was, that immenſe quantities of French goods were carried to Turkey by ſubjects of the porte; but the company at Marſeilles found means to get their excluſive privilege renewed; they had ſuffered, but the country had gained. At

preſent

preſent every one has liberty to trade; and ſince our fleet has left the Mediterranean, their commerce is revived, and, except the trade to Great Britain be equally free when a peace takes place, we ſhall have little chance of being able to rival them: but we muſt not wait till that period arrives to lay our trade open; it muſt be done immediately.

As all communication with the Levant by ſea is cut off, there remains no reſource to our merchants, but to carry on their trade through Ruſſia; and though this be a circuitous way, it is not by far ſo expenſive as might be imagined. The freights to the Baltic are very low, as half the ſhips go out empty. The carriage from Riga to Cherſon, or Niccolai on the Bog, is moſtly by water, and the land carriage in Ruſſia is not one fourth of the price it is in Germany. The expence on cloth would be trifling, and on cheap and bulky goods even would not be equal to the enormous price of inſurance paid for armed ſhips, which run the voyage at preſent, and which is not equal to the riſk; it is indeed ſo great, that government ſhould, perhaps, interfere. At Cherſon there are good veſſels to be found, which in three days may carry the goods to Conſtantinople at a reaſonable freight.

But in order to open ſuch a communication, liberty muſt be obtained of the emperor of Ruſſia to ſend merchandize in *tranſito* (without paying duty) acroſs Ruſſia; and there is no doubt but that ſovereign, who has ſtudied Adam Smith's book on the Wealth of Nations, and who is perfectly acquainted with the principles of commerce and navigation, would ſee the very great advantage which would accrue to Ruſſia by ſuch a trade, both on account of the ſums which would remain in the country for expences of carriage, the employment of a number of people, and alſo the encouragement it would be to the Ruſſian navigation in the Black Sea; but he never would *grant* ſuch a privilege to a part of the Britiſh nation excluſively, and ſhut out from it the Ruſſia merchants, who carry on a branch of commerce ſo advan-

tageous to his empire, nor exclude his own ſubjects from it. Before this can be done, the Turkey Company muſt be aboliſhed.

At preſent a few goods, I am informed, have been ſent to Hamburgh, thence to Vienna, and down the Danube, where they are ſhipped for Conſtantinople. The freight to Hamburgh is dearer than it is to Riga; the charges acroſs Germany ten times as much as acroſs Ruſſia. At the mouth of the Danube there are only bad Turkiſh or Greek veſſels to be freighted, on which no regular inſurance can be made. At Cherſon there are ſome hundreds of veſſels, among which many equal thoſe to be found in the ports of other ſeas, and a reaſonable inſurance may be made on them by ſafe underwriters; but the route through Germany does not neceſſitate an abolition of the Levant Company.

VIII. *Obſervations on Naples Yellow, and the different Methods of preparing it. By Profeſſor* BECKMANN.

NAPLES yellow, which is alſo called Neapolitan earth, in Italian *Giallolino*, and in French *Jaune de Naples*, has the appearance of an earth, is of a pale orange-yellow colour, ponderous, granulated, exceedingly friable, does not efflorefce, nor become moiſt when expoſed to the air, but when applied to the tongue ſeems to adhere to it. When reduced to a fine powder, it remains for ſome time ſuſpended in water, but ſoon depoſits itſelf at the bottom in the form of a ſlime. When boiled with water, the water, at leaſt ſometimes, is obſerved to have a ſomewhat ſaline taſte. It does not effervefce with acids, but is in part diſſolved by aqua-regia (*nitro-muriatic acid*). In the fire it emits no ſulphureous vapour, is difficult to be fuſed, and by that operation undergoes no material change, only that its colour becomes ſomewhat redder. When fuſed with colourleſs glaſs, it gives it a milk-

milk-white colour, a ſure proof that it contains no iron; and, with inflammable ſubſtances, there is obtained from it a regulus which has the appearance of a mixture of lead and antimony.

This article is brought from Naples for the moſt part in the form of an earthy cruſt about three or four lines in thickneſs, and it ſometimes retains the form of the veſſel in which it has hardened. It can be procured alſo as a fine powder, as the colourmen keep it ſometimes ready pounded for uſe.

How long this colour has been an article of trade I will not venture to determine. As far as I know, Pomet is the firſt druggiſt who mentions it; but he tells us that it was exceedingly ſcarce. Kunckel, who has carefully enumerated all the ſubſtances proper for colouring glaſs, and for glazing earthen-ware, does not, as far as I have obſerved, take any notice of Naples yellow; but if names alone can afford any proof of antiquity, I would aſſert that this colour was known in Italy at any rate, about the end of the ſixteenth century; for Ferrante Imperato *, whoſe book was firſt printed in the year 1599, ſays that "there are two kinds of *giallolino*, one of which is produced from white lead by the firſt alteration." This paſſage ſeems to allude to the real Naples yellow; but perhaps he only meant the yellow calx (*oxyd*) of lead, or the ſo called maſſikot. Reſpecting the other kind, he gives no

* *Hiſtoria naturale.* Venetia, 1672. fol. p. 107: Il giallolino si fa di ceruſſa nella prima alteratione; imita nel colore il fior di gineſtra. Evvi un' altro giallolino, di cui tratteremo tra li ſmalti e l'impetente. Il minio moderno, o ſandice de antichi, si fa dell' iſteſſa ceruſſa, e giallolino paſſato in maggior roſſeza par la maggior cottura. In the Latin tranſlation printed at Cologne 1695, 4to, this paſſage can ſcarcely be known to be the ſame. *Lib.* iv. *cap.* 42, *p.* 132: Flavum e ceruſſa in prima alteratione efficitur, florem geniſtæ colore imitatur. Eſt et aliud flavi coloris genus, quo de inter encauſta atque dealbationes tractaturi ſumus. Minium modernum, vel antiquorum ſandyx, ex eadem fit ceruſſa, et flavo acriori coctione in majorem rubidinem tranſmigrante. I ſuſpect that the term *giallolino* was uſed earlier than the pigment to which that name has been excluſively applied.

explanation. But, however this may be, it is certain that no writer ever yet knew properly what the nature of this paint really is. Moſt of them have conſidered it as originating from fire, and as a volcanic production of Mount Veſuvius or Mount Ætna *; others have pronounced it to be a natural ochre †. Guettard thought it rather a kind of bole ‡; but Pott approached neareſt the truth, by aſſerting it to be an artificial preparation §. Fougeroux is entitled to the merit of having proved this, and of having ſhewn the poſſibility of preparing it. According to his experiments, Naples yellow will be obtained, if you boil for ſeven or eight hours, firſt over a ſlow and then over a ſtrong fire, a mixture finely pulveriſed of twelve parts of pure white lead, one part of alum, one part of ſal ammoniac, and three parts of diaphoretic antimony || (*white oxyd of antimony by nitre*). But before Fougeroux, who may have obtained an account of the proceſs during his Travels through Italy, a more certain proceſs was publiſhed in the year 1758, by Giambattiſta Paſſeri, in his intereſting work on the painting of earthenware ¶. The articles to be employed, according to this author, are, "one pound of antimony, a pound and a half of lead, one ounce of *allume di feccia*, and the ſame quantity

* Among theſe are Pomet, two writers in the firſt edition of the *Encyclopedie*, Montamy in *Abhandlung von den Farben zum Porzellan*, Leipzig, 1767, 8vo, p. 266, and the editor of *Dictionnaire portatif de peinture, ſculpture et gravure*, 1757, p. 363.

† For example, Hill in his *Hiſtory of Foſſils*, vol. i. p. 55, 66. Gadd alſo in *Inledning til Sten-Rikets Kœnning*. Abo, 1787, 8vo, p. 49, mentions Naples yellow among the calcareous earths mixed with metallic calces.

‡ In *Memoire ſur les ocres*, to be found in the Memoirs of the Academy of Sciences for the year 1762.

§ Lithogeognoſie. II. p. 15.

|| In the Memoirs of the Academy of Sciences for the year 1766. p. 303.

¶ This paper may be found in *Nuova raccolta d'opuſcoli ſcientifici*. t. iv. 1758. p. 103. Il giallolino, o color d'oro, ſi fa con una libra di antimonio, una e mezza di piombo, ed un'oncia d'allume di feccia, ed un'altra di ſal commune.

of common ſalt." I am inclined to think that this receipt was not unknown to Fougeroux, and that he conſidered *allume di feccia* to be alum. Profeſſor Leonhardi, a man of very ſound learning, has tranſlated this expreſſion by the word alum. I will, however, freely confeſs, that I conſider *allume di feccia* not to mean alum, but ſalt of tartar, or potaſh *. Paſſeri ſays that the proportions may be varied different ways; and he gives ſix other receipts, in which he does not mention *allume di feccia*, but only *feccia* † ; and this word certainly means *weinhefen* or wineſtone (*tartar*). Profeſſor Leonhardi himſelf ſeems to confirm this opinion, by ſaying, that Vairo, profeſſor of chemiſtry at Naples, has tranſlated "the aſhes of wine lees" (*cineres infectorii*) by the words *allume di feccia* ‡.

After

* In the 2nd edition of Macquer's *Chemical Dictionary*, vol. iv. p. 133.

† *Page* 103. Si avverte, che diverſificando le doſi, ſi diverſifica puranco la riuſcita del colore on l' è che alcune ſcuole, o fabbriche hanno avuto colori molto differenti dagli altri, anzi io oſſervo, che nelle antiche Majoliche ogni pezzo ha tinte differenti, perche ogni maeſtro preparava i colori a ſuo modo, ed eccone alcune differenti doſi. Then follow ſix different receipts, as above mentioned :—1. Piombo libre ſei, antimonio libre quattro, feccia libra una. 2. Piombo libre tre, antimonio libre due, feccia libra una, ſale once ſei. 3. Piombo libre cinque, antimonio libre quattro, feccia once ſei. 5. Piombo libra una e mezza, antimonio libra una, feccia libra una, ſale libra una. 6. Piombo libre tre e mezza, antimonio libre due, feccia libra una.

For the ſake of the Engliſh reader we ſhall here give a tranſlation of the above ſix receipts, without pretending to explain the word *feccia*, as we confeſs we cannot throw more light upon it than Prof. Beckmann has done.—1. Six pounds of lead, four pounds of antimony, and one pound of *feccia*. 2. Three pounds of lead, two pounds of antimony, one pound of *feccia*, and ſix ounces of ſalt. 3. Five pounds of lead, four pounds of antimony, and ſix ounces of *feccia*. 4. Four pounds of lead, two pounds of antimony, and ſix ounces of *feccia*. 5. One pound and a half of lead, one pound of antimony, one pound of *feccia*, and one pound of ſalt. 6. Three pounds and a half of lead, two pounds of antimony, and one pound of *feccia*.

‡ In the firſt part, page 245. One great advantage of the new edition by Profeſſor Leonhardi is, without doubt, the addition of the foreign terms

of

After Fougeroux's paper was printed, De la Lande publiſhed a receipt which he had received from the well-known prince San Severo, and in which lead and antimony only are employed; but no mention is made either of alum, tartar, or any other ſalt *.

The fixity of this pigment, a property in which lead ochres, when uſed alone, are deficient, is aſcribed by Fougeroux to the antimony and alum. The latter, perhaps, may not be neceſſary, but the addition of the former is indiſpenſible. It is well known that the glaſs of antimony has a hyacinth colour, and that with red lead and flint it produces glaſs of a gold colour †.

Artiſts generally complain that this pigment often fails in its application, becauſe they cannot always procure it of an equal quality. This difference ariſes in all probability from

of art. As dictionaries, and particularly thoſe of the Italian language, are in general deficient in regard to ſcientific expreſſions, it would be doing a great ſervice to the public if ſome man of learning would collect and explain all thoſe which relate to chemiſtry and mineralogy. At any rate tranſlators ought to follow the good example ſet them by M. Leonhardi.

* I ſhall here give the whole receipt as it ſtands in the laſt part of the neweſt edition of *Voyage en Italie*, par De la Lande. Paris, 1786. 9 vol. 12mo, p. 504: Take lead well calcined and ſifted, with a third part of its weight of antimony pounded and ſifted alſo. Mix theſe ſubſtances well together, and ſift them again through a piece of ſilk. Then take large flat earthen diſhes, not varniſhed, cover them with white paper, and ſpread out the powder upon them to the depth of about two inches. Place theſe diſhes in a potter's furnace, but only at the top, that they may not be expoſed to too violent a heat. The reverberation of the flame will be ſufficient. The diſhes may be taken out at the ſame time as the earthen-ware, and the ſubſtance will then be found hard, and of a yellow colour. It is then pounded on a piece of marble with water, and afterwards dried for uſe. This is what is called Naples yellow.

† To this ſubject belong the experiments of Lewis, who, though he carefully examined all thoſe ſubſtances which ſeemed proper for colouring glaſs, makes, however, no mention of Naples yellow. See his *Philoſophical Commerce of the Arts*.

the ſame proportions of the two metals, and the tartar not being always employed, as Paſſeri has ſaid; but the inconvenience might eaſily be prevented, if the workmen who prepare Naples yellow would work according to a ſample, as is the caſe in regard to ſmalt; and if the different qualities were in the like manner marked by numbers or characters. Fougeroux was informed, from Naples, that there was an old man ſtill living there who prepared this yellow, but that he kept his art ſuch a profound ſecret that it was apprehended it would die with him. Nothing more of it was known than that he expoſed the metals which he employed to the heat of a potter's furnace for twenty-four hours.

Thoſe who attempt to prepare this colour in Germany will not certainly ſet the ſame value on the Italian receipt, and that given by Fougeroux; for the diaphoretic antimony, as well as white lead, are too dear—and ſal ammoniac, which is not cheap, is loſt in the proceſs. On the other hand, ſome advantage might be gained, if, according to the Italian method, both the metals, with a ſmall addition of an alkaline ſalt, were reduced to the ſtate of oxyds in an earthen-ware furnace. But our enamel painters prepare a yellow glazing not very different from the real Naples yellow, and for which I find a receipt in a new work*, the author of which ſeems to be a man of experience, but not of learning. According to this preſcription, one pound of antimony, ſix ounces of red lead, and two ounces of white ſand, are to be fuſed together. The produce, which appears quite black, is to be pounded, and then fuſed again; and this proceſs is to be repeated till the whole maſs becomes thoroughly yellow. Half a pound of this maſs is to be mixed with two ounces of red lead, and afterwards fuſed; and by this tedious proceſs an orange-yellow pigment will be obtained, which, however, might be obtained with more eaſe and certainty by the method pointed out above.

* Vollig entdeckes geheimniſs der kunſte fayence, Engliſches ſteingut, und porzellan zu machen. Leipzig, 1793, 8vo, p. 54.

All

All artifts who fpeak of the ufe of Naples yellow, give cautions againft applying iron to it, as the colour by thefe means becomes greenifh, or at leaft dirty. For this reafon, it muft be pounded on a ftone, and fcraped together with an ivory fpatula. It is employed chiefly in oil painting, becaufe the colour is fofter, brighter, and richer than that of ochre, yellow lead, or orpiment, and becaufe it far exceeds thefe pigments in durability. It is employed in particular when the yellow ought to have the appearance of gold, and in this refpect it may be prepared with gum water and ufed as a water colour. A ftill greater advantage of it is, that it is proper for enamel painting, and on that account may be employed on porcelain or earthen ware *. In the laft place I would recommend to artifts to examine whether the oxyd prepared from wolfram, by boiling in the muriatic acid, which has a beautiful yellow colour, might not be ufed in the fame manner as Naples yellow †.

IX. *Comparifon between the Human Race and that of Swine.* *By* I.F. Blumenbach. *From* Magazin für das Neueſte aus der Phyſik. *Vol. VI.*

SOME late writers on natural hiſtory ſeem doubtful whether the numerous diſtinct races of men ought to be conſidered as mere varieties, which have ariſen from degeneration, or as ſo many ſpecies altogether different. The cauſe of this ſeems chiefly to be, that they took too narrow a view in their reſearches; ſelected, perhaps, two races the moſt different from each other poſſible, and, overlooking the intermediate races that formed the connecting links between them, compared theſe two together; or, they fixed their

* In the Memoirs of the Academy of Sciences for 1767 Fougeroux has proved that the giallolino prepared by him produced on porcelain a much more beautiful colour than the Naples yellow ſold in the ſhops.

† Gmelin's Techniſche Chemie, p. 229.

attention

attention too much on man, without examining other ſpecies of animals, and comparing their varieties and degeneration with thoſe of the human ſpecies. The firſt fault is, when one, for example, places together a Senegal negro and an European Adonis, and at the ſame time forgets that there is not one of the bodily differences of theſe two beings, whether hair, colour, features, &c. which does not gradually run into the ſame thing of the other, by ſuch a variety of ſhades that no phyſiologiſt or naturaliſt is able to eſtabliſh a certain boundary between theſe gradations, and conſequently between the extremes themſelves.

The ſecond fault is, when people reaſon as if man were the only organiſed being in nature, and conſider the varieties in his ſpecies to be ſtrange and problematical, without reflecting that all theſe varieties are not more ſtriking or more uncommon than thoſe with which ſo many thouſands of other ſpecies of organiſed beings degenerate, as it were, before our eyes.

As my obſervations reſpecting the bodily conformation and mental capacity of the negroes * may ſerve to warn mankind againſt the firſt error, and at the ſame time to refute it, I ſhall here offer a few remarks to refute the falſe concluſion which might be formed from a careleſs compariſon of the degenerations among the human race with the varieties among other animals, and for that purpoſe ſhall draw a compariſon between the human race and that of ſwine †.

More reaſons than one have induced me to make choice of ſwine for this compariſon; but in particular, becauſe they have a great ſimilarity, in many reſpects, to man: not, however, in the form of their entrails, as people formerly believed, and therefore ſtudied the anatomy of the human

* See Phil. Mag. vol. iii. p. 141.

† See, for example, *Anatomia Porci* of the old Arabian Cophon in the beginning, where he ſays: Et cum bruta animalia quædam, ut ſimia, in exterioribus nobis inveniantur ſimilia, interiorum partium nulla inveniuntur adeo ſimilia ut porci.

body

body purpoſely in ſwine; ſo that even, in the laſt century, a celebrated diſpute, which aroſe between the phyſicians of Heidelberg and thoſe of Durlach, reſpecting the poſition of the heart in man, was determined in conſequence of orders from government, by inſpecting a ſow, to the great triumph of the party who really were in the wrong. Nor is it becauſe in the time of Galen, according to repeated aſſertions, human fleſh was ſaid to have a taſte perfectly ſimilar to that of ſwine *; nor becauſe the fat †, and the tanned hides of both, are very like to each other; but becauſe both, in regard to the economy of their bodily ſtructure, taken on the whole, ſhew unexpectedly, on the firſt view, as well as on cloſer examination, a very ſtriking ſimilitude.

Both, for example, are domeſtic animals; both *omnivora*; both are diſperſed throughout all the four quarters of the world; and both conſequently are expoſed, in numerous ways, to the principal cauſes of degeneration ariſing from climate, mode of life, nouriſhment, &c.; both, for the ſame reaſon, are ſubject to many diſeaſes, and, what is particularly worthy of remark, to diſeaſes rarely found among other animals than men and ſwine, ſuch as the ſtone in the bladder ‡; or to diſeaſes excluſively peculiar to theſe two, ſuch as the worms, found in meaſled ſwine §. Another

* Galen ſays, in the tenth book of his work on the Power of Simple Medicines, that tavern-keepers and cooks often ſerved up human fleſh inſtead of ſwine's fleſh to their gueſts, without their perceiving it. He himſelf was told by perſons worthy of credit, that they had ate of ſuch food in a public inn with the beſt appetite, not knowing what it was till they at length found half a finger, when they became terribly alarmed for fear of the murderous hoſt, who was, however, ſoon after caught in the fact and puniſhed.

† See *Schwenkfeld Theriotróph. Sileſiæ*, p. 127.

‡ Among the wild ſwine, particularly in Ruſſian Tartary. A pretty large ſtone of that kind, forming a part of Baron Aſch's preſent, is preſerved in the Academical Muſeum of Gottingen. Domeſtic ſwine, however, are in many places ſubject to this malady. See *Schwenkfeld Theriotroph. Sileſiæ*, ut ſupra.

§ I was guilty of an error when I ſaid, in the third edition of my Manual

Another reaſon, however, why I have made choice of ſwine for the preſent compariſon is, becauſe the degeneration and deſcent from the original race are far more certain in theſe two animals, and can be better traced than in the varieties of other domeſtic animals. For no naturaliſt, I believe, has carried his ſcepticiſm ſo far as to doubt the deſcent of the domeſtic ſwine from the wild boar; which is ſo much the more evident, as it is well known that wild pigs, when caught, may be eaſily rendered as tame and familiar as domeſtic ſwine *: and the contrary alſo is the caſe; for if the latter by any accident get into the woods, they as readily become wild again, ſo that there are inſtances of ſuch animals being ſhot for wild ſwine; and it has not been till they were opened and found caſtrated, that people were led to a diſcovery of their origin, and how and at what time they ran away †. It is well aſcertained, that, before the diſcovery of America by the Spaniards, ſwine were unknown in that quarter of the world, and that they were afterwards carried thither from Europe. All the varieties, therefore, through

Manual of Nat. Hiſtory, p. 464, that Goze was the firſt who placed the animal nature of the meaſles in ſwine beyond all doubt. I now find that in the laſt century Malpighi gave an accurate deſcription of the diſeaſe, accompanied alſo with a figure of the worms. See his *Opera Poſthuma*, London 1697, fol. p. 84. "In ſuibus verminoſis, qui vulgariter *lazaroli* dicuntur, multiplices ſtabulantur vermes, unde horum animalium carnes publico edicto prohibentur. Occurrunt autem copioſi intra fibras muſculoſas natium; obvia namque oblonga veſica quaſi folliculus diaphano humore refertus, in quo natat globoſum corpus candidum, quod diſrupto folliculo leviter compreſſum eructat vermem, qui foras exeritur, et videtur emulari cornua emiſſilia cochlearum, ejus enim annuli intra ſe reflexi conduntur, et ita conglobatur animal. In apice attollitur capitulum. A conglobato verme ad extremum folliculi umbilicale quaſi vas producitur." The late Werner, as far as I know, was the firſt who diſcovered in the human body the ſame kind of worms as thoſe found in meaſled ſwine.

* This experiment was not long ago made with the beſt conſequences in the abbey of St. Urban, in the canton of Lucerne.

† See Lehmann's *Naturliche merkwürdigkeiten im Meiſſniſchen Obererzgebirge*, p. 605.

which

which this animal has ſince degenerated, belong, with the original European race, to one and the ſame ſpecies; and ſince no bodily difference is found in the human race, as will preſently appear, either in regard to ſtature, colour, the form of the cranium, &c. which is not obſerved in the ſame proportion among the ſwine race, while no one, on that account, ever doubts that all theſe different kinds are merely varieties that have ariſen from degeneration through the influence of climate, &c. this compariſon, it is to be hoped, will ſilence thoſe ſceptics who have thought proper, on account of theſe varieties in the human race, to admit more than one ſpecies.

I. *In regard to Stature.*

In this reſpect the Patagonians *, as is well known, have afforded the greateſt employment to anthropologiſts. The romantic tales, however, of the old travellers, who give to theſe inhabitants of the ſouthern extremity of America a ſtature of ten feet and more, are ſcarcely worth notice; and even the more modeſt relations of later Engliſh navigators, who make their height from ſix to ſeven feet, have been doubted by other travellers, who, on the ſame coaſt, ſought for ſuch children of Enoch in vain. But we ſhall admit every thing ſaid of the extraordinary ſize of theſe Patagonians, by Byron, Wallis, and Carteret, the firſt of whom † aſſigns to their chief, and ſeveral of his attendants, a height of not leſs than ſeven feet, as far as could be determined by the eye; the ſecond ‡, who aſſerts that he actually meaſured them, gives to the greater part of them from 5 feet 10 inches to 6 feet; to ſome 6 feet 5 inches, and 6 feet 6; but to the talleſt, 6 feet 7 inches: and this account is confirmed by the laſt-mentioned

* Or rather Pata-chonians, for the people themſelves are called *Chonos;* and becauſe their feet, covered with raw hides, gave them a likeneſs to a bear's paws, they were called by the firſt Spaniſh navigators *patachonos*. See Forſter in *Comment. Soc. Scient. Gottingenſ.* vol. iii. p. 127.

† Hawkeſworth's Collection of Voyages, London, 1773. vol. i. p. 27.

‡ Ibid. p. 153.

of

of the above circumnavigators *. Now, allowing this to be the caſe, it is not near ſuch an exceſs of ſtature as that obſerved in many parts of America among the ſwine, originally carried thither from Europe; and of theſe I ſhall mention in particular thoſe of Cuba †, which are more than double the ſize of the original ſtock in Europe.

II. *In regard to Colour, and the Nature of Hair.*

The natives of Guinea, Madagaſcar, New Holland, New Guinea, &c. are black; many American tribes are reddiſh brown, and the Europeans are white. An equal difference is obſerved among ſwine in different countries. In Piedmont, for example, they are black. When I paſſed through that country, during the great fair for ſwine at Salenge, I did not ſee a ſingle one of any other colour. In Bavaria, they are reddiſh brown; in Normandy, they are all white.

Human hair is, indeed, ſomewhat different from ſwine's briſtles, yet in the preſent point of view they may be compared with each other. Fair hair is ſoft, and of a ſilky texture; black hair is coarſer, and among ſeveral tribes, ſuch as the Abyſſinians, Negroes, and the inhabitants of New Holland, it is woolly, and moſt ſo among the Hottentots ‡. In the like manner, among the white ſwine in Normandy, as I was aſſured by an incomparable obſerver, Sulzer of Ronneburg, the hair on the whole body is longer and ſofter than among other ſwine; and even the briſtles on the back are very little different, but lie flat, and are only longer than the hair on the other parts of the body. They cannot, therefore, be employed by the bruſh-makers. The difference between the hair of the wild boar and the domeſtic ſwine, particularly in regard to the ſofter part between the ſtrong briſtles, is, as is well known, ſtill greater.

* Philoſoph. Tranſactions, vol. lx. p. 20.

† F. S. Clavigero Storia Antica del Meſſico, vol. iv. p. 145.

‡ Sparmann ſays, the hair of the Hottentots is more woolly than that of the Negroes.

III. *In regard to the Form of the Cranium.*

The whole difference between the cranium of a negro and that of an European, is not in the leaſt degree greater than that equally ſtriking difference which exiſts between the cranium of the wild boar and that of the domeſtic ſwine. Thoſe who have not obſerved this in the animals themſelves, need only to caſt their eye on the figure which Daubenton has given of both.

I ſhall paſs over leſs national varieties which may be found among ſwine as well as among men, and only mention that I have been aſſured by Mr. Sulzer that the peculiarity of having the bone of the leg remarkably long, as is the caſe among the Hindoos, has been remarked with regard to the ſwine in Normandy. "They ſtand very long on their hind legs," ſays he, in one of his letters; "their back, therefore, is higheſt at the rump, forming a kind of inclined plane; and the head proceeds in the ſame direction, ſo that the ſnout is not far from the ground." I ſhall here add, that the ſwine, in ſome countries, have degenerated into races which in ſingularity far exceed every thing that has been found ſtrange in bodily variety among the human race. Swine with ſolid hoofs were known to the ancients, and large herds of them are found in Hungary, Sweden, &c. In the like manner the European ſwine, firſt carried by the Spaniards in 1509 to the iſland of Cuba, at that time celebrated for its pearl fiſhery, degenerated into a monſtrous race, with hoofs which were half a ſpan in length *.

* Herrera Hiſtoria de las Indias Occident. Madrid 1601, vol. 1. p. 239.

X. *Account of the Method of making Sugar from Beet Roots, lately discovered by* M. Achard. *Communicated by* A. N. Scherer, *Counsellor of Mines to the Duke of Saxe Weimar.*

Weimar, 14th Feb. 1799.

THE newest and most important discovery in Germany is that of the well known M. Achard, director of the physical class of the Academy of Sciences at Berlin, who has at length found a substitute for sugar in the beet root, (*Beta vulgaris*, Linn.) These beets in this country have been hitherto employed as fodder for cattle. The following is one of his principal experiments:—Twenty-five roots, which in their raw state weighed 32½ pounds, being freed from the rind, bruised, and well pressed, gave, after the residuum had been extracted by boiling water, 19¾ pounds of juice. The expressed juice was then put into a tin saucepan, and evaporated to the consistence of honey over a slow fire. During this process the impurities contained in the juice, and which arose from the albumen of the beets, were scummed off. The inspissated salt was next evaporated to dryness over a slower fire, and gave, when pounded, a dry powder of a very bright brown colour, which attracted little or no moisture; it was exceedingly sweet, without the intermixture of any other taste, and weighed two pounds three ounces. The above quantity, viz. 32½ pounds of the raw roots, gave, therefore, two pounds three ounces of raw sugar. By another experiment it appeared, that a pound of this juice contained only ¾ of an ounce, or at most one ounce of gummy and mucilaginous particles: a circumstance which greatly facilitated the separation of the sugar. To obtain a portion of pure sugar from a quantity of juice evaporated and treated as above described, a portion of the juice, inspissated to dryness, was digested with a sufficient quantity of alcohol in a gentle heat; and after all the saccharine matter was dissolved, and the liquor had become perfectly cold, it was filtred

and the reſiduum properly edulcorated with a ſuitable quantity of alcohol. When all the ſpirit of wine had evaporated * over a gentle fire, the quantity of the pure white ſugar obtained was ſuch that in general 8 pounds of pure ſugar may be expected from 100 pounds of raw beet roots. According to this reſult, an acre of land, which may produce 46,000 pounds of beet root, will yield 22 hundred weight of raw ſugar. If we allow four pounds of beet root to one ſquare foot, a German mile will produce 16,756 hundred weight 2 quarters and 14 pounds. This is all as yet known reſpecting the diſcovery. What M. Achard ſtill keeps ſecret is the reſult of his fifteen years experience reſpecting the cultivation of theſe beets. He has found that the quantity of ſugar to be obtained will depend on the ſoil in which they are ſown, and the method of culture employed. The king of Pruſſia has not only beſtowed a conſiderable reward on M. Achard for this diſcovery, but is purſuing every poſſible means to render it beneficial to his dominions.

XI. *Deſcription of an Improved Machine for Cutting Chaff* †, *invented by Mr.* ROBERT SALMON, *of Woburn, Bedfordſhire. From* Tranſactions of the Society for the Encouragement of Arts, &c. *Vol. XV.*

WITH this machine the chaff is cut by two knives, A A, (Plate VI.) fixed on the inſide of the fellies of two wheels, B B, which are ſtrongly connected together; the edge of the knives being at an angle of about forty-five degrees from the plane of the wheel's motion. Theſe knives are ſo fixed as to be forced forward by ſprings, C C, on the wheel; which ſprings are formed to adjuſt, and act more or

* Diſtillation might be employed to ſave the loſs of the alcohol. EDIT.

† Thirty guineas were voted to Mr. Salmon for this improved machine, of which a model is reſerved in the Society's repoſitory for the inſpection of the public.

leſs

leſs as occaſion may require, ſo as to give the knife as much preſſure againſt the box as may be requiſite to cut the ſtraw. The knives are prevented from coming too forward, and occaſioning unneceſſary friction, by the wedges under the ſtaples *a a*; which wedges, as the knives wear, muſt be drawn out ſo as to admit the knives to come more forward. With the before-mentioned proviſions it will be found very eaſy at any time to put on new knives, as the ſprings, &c. will always adjuſt them to their work.

On one ſide of the wheel is fixed a round block of wood, D, in which there are four holes and a moveable ſcrew; to this block is ſcrewed one end of the feeding-arm, E, running nearly horizontally to the croſs bar F, at the end of the box G; to which croſs bar E is attached by the pin *b*, moveable to five different holes in F, by means of which, and the four holes in the block before deſcribed, twenty changes in the length of the chaff may be obtained. The ſtraw is brought forward by the rollers in the box G, the form of which is ſhewn at Fig. 2; which rollers are turned from the outſide by the riggers or ratchet-wheels, H, one on each ſide the box, which move more or leſs, according to the ſtroke given to the croſs bar by the feeding-arm and wheel: by this mode of feeding, the ſtraw is perfectly at reſt, and does not preſs forward at the time of the knife cutting; and, by means of the pin being taken out of the croſs bar, the feeding is inſtantly thrown off, although the wheel and knives may continue their motion. Under the box is ſuſpended the preſſing weight I, which may be made more or leſs powerful by ſhifting the weight on the bearer K, to which it hangs, and alſo may be thrown on either ſide, more or leſs, as occaſion may require; which will be found uſeful, in order to force the ſtraw towards the knife, and to counterbalance the ratchet-wheel of the upper roller: near the fulcrum of this bearer is fixed a chain, ſhewn by the dotted line *c*; its upper end ſuſpended from a roller; at each extremity of which is a ſmall bar of iron joined to

the end of the upper ſpiked roller, by which means the ſtraw is always equally preſſed in paſſing the two-ſpiked rollers.

L. The winch by which the machine is turned.

M M. The frame of the machine.

In order to apply this machine to the beſt advantage, the inventor propoſes a ſecond box to be placed at the end of the firſt, which box may be of any length, and ſuſpended by a line and counter-weight, whereby the end of it is brought down level whilſt filling with ſtraw, and then drawn up, ſo as to give the ſaid box a declivity, to make the ſtraw more eaſily come forward.

It is alſo preſumed much advantage may be expected in this ſort of machine, from its cutting various lengths—reſting during the cut—the knives being adjuſted to their work by regulating ſprings—the feeding being readily thrown off—and the preſſure moveable to either ſide.

It is alſo well calculated to be applied to any power which may be occaſionally fixed to the oppoſite ſide of that on which it is turned by hand; and, by the additional box, when uſed by hand, the workman will be enabled to cut for ſome continuance, without ſtopping to feed.

XII. *Agenda, or a Collection of Obſervations and Reſearches the Reſults of which may ſerve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE. *From* Journal des Mines. *No. XX.*

[Continued from page 156.]

CHAP. XII.

Obſervations to be made on the Valleys.

1. TO obſerve the direction of valleys. Thoſe parallel to the chain of the mountains where they are ſituated are called longitudinal; thoſe which interſect it at right angles, tranſverſal;

verſal; and thoſe which follow an indeterminate direction, oblique.

2. To obſerve this direction, eſpecially in regard to that of the planes of the ſtrata of the mountains.

3. Dimenſions of the valleys; their length, breadth, depth, and the form of their tranſverſal ſection.

4. The re-entering and ſalient angles: whether oppoſite to each ſalient angle, which forms a ſide of the valley, the ſide or oppoſite mountain forms a re-entering angle; or, on the other hand, whether the valley does not preſent alternate conſtrictions and ſwellings?

5. Whether the oppoſite mountains correſpond by their height, their form, the inclination of their correſponding faces; the ſituation of their ſtrata, or their nature?

6. Anſwers to theſe queſtions will ſerve to determine whether the valley may or may not be conſidered as a large fiſſure produced by the burſting aſunder of the mountains which it traverſes.

7. If the lateral valleys which terminate at a principal valley, as the branches of a tree at its trunk, correſpond or not; or, in other words, whether the branches of that trunk are oppoſite or alternate?

The anſwers to theſe two queſtions are very important for the ſolution of this queſtion: Whether the valleys have been excavated by currents of the ſea?

9. Whether there are ſeen a great number of narrow valleys, of no great depth at their moſt elevated part, but becoming wider and deeper in proportion as they deſcend lower, which would ſeem to indicate that their excavation has been the effect of the fall and deſcent of water; eſpecially if the ſtrata have the ſame inclination on each ſide of the valley, and if its formation cannot be explained by a ſinking down or heaving up of the earth.

10. To obſerve in a valley, the correſponding mountains of which are of the ſame nature, whether the ſtrata of theſe mountains do not deſcend on each ſide towards the bottom

of the valley, which would indicate that the valley has been produced by a ſinking down of the earth, or perhaps by the oppoſite faces being thrown up.

11. There are two other caſes poſſible when the ſtrata have not the ſame ſituation on both ſides of the valley. 1. When the ſtrata riſe up on each ſide againſt the valley. 2. When on one ſide they deſcend into the valley, and on the other riſe againſt it. Theſe two caſes afford room for ſuppoſitions too various to be here detailed.

12. To ſearch on the vertical ſides of the valleys for veſtiges of the eroſion of the water.

13. To obſerve the bottom of the valley, its breadth, inclination and nature. The vegetable earth, its quantity and quality; fragments, either from neighbouring mountains, or brought from a diſtance, either angular or rounded; to examine whether they are more voluminous towards the top of the valley. Nature and depth of the ſtrata which are below the vegetable earth; whether the pebbles are larger in the deepeſt ſtrata: nature of the rock which forms the ſolid baſis of the valley.

14. Whether a valley contains foreign pebbles, that is to ſay, which come from the neighbouring mountains: to examine to what height they are found on the ſides of the mountains; what may be their origin, and what way they may have been conveyed.

15. In the valleys which contain no foreign pebbles, one may follow the traces of thoſe which are there diſcovered, and thus aſcend to the rock from which they were detached: this has often led to curious and uſeful diſcoveries.

CHAP. XIII.

Obſervations to be made on Tertiary Mountains, or thoſe compoſed of the Wreck of other Mountains.

1. Whether they do not form the external border of other chains of mountains.

2. Whether, at the extremity of great valleys which iſſue from

from grand chains of mountains, there are not found ſmall hills and even tertiary mountains, which ſeem to have been formed by the accumulation of matters depoſited by enormous currents that iſſued formerly from theſe valleys.

3. Whether their ſtrata do not deſcend on the ſide, whence the matter of which they are formed has proceeded?

4. Size and nature of the fragments, ſand and earth, of which they are compoſed.

5. To obſerve the order which has been followed in the ſucceſſive depoſits of the matters of which they are formed.

6. To compare them with the ſubſtances produced by the mountains, whether primitive or ſecondary, from which they are ſuppoſed to have iſſued.

7. To examine whether there are found there any veſtiges of organiſed bodies.

8. To examine whether there are not found, in their exterior part or ſurface, ſtrata that ſeem to have been depoſited by ſtagnant water, or at leaſt water not much agitated; or, on the contrary, whether every thing in them ſeems to have been tranſported by ſome violent movement?

CHAP. XIV.

Obſervations to be made on Secondary Mountains.

1. To determine with preciſion the diſtinguiſhing characters between primitive and ſecondary mountains. This is difficult, eſpecially in the genera found equally in primitive mountains, ſuch as ſlate, ſerpentines, and ſome kinds of *trapps* and porphyry. With regard to the calcareous, a granulated fracture ſeems to characteriſe the primitive. M. Fichtel, however, doubts this principle, and believes that there are ſecondary granulated, calcareous, and compact primitives.

2. Is it certain, as Dolomieu aſſerts, that in ſecondary mountains there are no ſtrata compoſed entirely of granulated and cryſtalliſed ſtones?

3. To

3. To determine the reſpective antiquity of the genera and ſpecies of the earths and ſtones which enter into the compoſition of ſecondary mountains. Might we not aſſign characters by which, in the ſame genus, we might diſtinguiſh the moſt modern ſpecies and varieties?

4. Whether the ſecondary mountains are always inclined in ſuch a manner as to lean towards the neareſt primitives?

5. Whether their ſuperior ſtratum, eſpecially in the compact calcareous, is not often a *breche**, the angular fragments of which are for the moſt part of the ſame nature as the ſtratum that ſerves them as a baſis, and united by a cement of the ſame nature†?

5. (A). To obſerve in the chalk mountains the flints contained there; their bulk, their form, &c.; whether they are diſpoſed in beds; to reflect on their origin: even reſearches on the petro-ſilex contained in the compact calcareous ſtones; and, laſtly, the ſame on the hard *rognons*, or touch-ſtones contained in the ſlate mountains: to aſcertain whether theſe petro-ſilex and rognons are not found in the primitive mountains.

6. Whether there are found in ſecondary mountains veſtiges of organiſed bodies, and at what elevation. This obſervation is important above all in the Auſtral hemiſphere‡.

7. Whether there are found, either at their ſurface, or in their interior parts, rolled pebbles or blocks of a nature different from that of the ſame mountain, and to what height‖?

8. Whether theſe mountains ſeem to have been formed by the alluvion of violent tides, or by the accumulated depoſits of ſtagnant water?

9. Whether the ſecondary mountains do not preſent them-

* Breche is a kind of hard marble found in the Pyrenees.

† Voyage dans les Alpes, vol. i. § 242. A. and 243.

‡ 6. A. Do not organiſed bodies contribute ſometimes to the hardneſs of ſtones, eſpecially thoſe that contain iron, by bringing that iron near to the metallic ſtate? *Hypotheſis of Gad in Mem. of the Acad. of Sweden*, 1787. C.

‖ See Dolomieu's Memoir Journal de Phyſique 1791, vol. ii.

ſelves

ſelves ſometimes in vertical ſtrata, or at leaſt ſtrata very much inclined, and with ſharp naked peaks like thoſe of ſome primitive mountains?

10. Whether, in the ſame ſecondary mountain, there are found ſtrata of different kinds of ſtones oftener than in the primitive?

11. Whether, in ſecondary mountains, on the other hand, each ſtone is not generally ſimple, and not compound as in the primitive?

12. To make reſearches reſpecting the origin and antiquity of mountains of gypſum, and their relation with mountains of ſalt and ſalt ſprings.

[To be continued.]

XIII. *Fourth Communication from Dr.* THORNTON, *Phyſician to the General Diſpenſary, relative to Pneumatic Medicine.*

Letter to Dr. Thornton.

DEAR SIR, Dulwich Common.

I RETURN you many thanks for your kind attentions to Mrs. R. Your method of treatment, under Providence, has certainly performed a wonderful cure. My wife had not inhaled the air three times before I perceived a very great alteration, both in regard to *appetite* and *ſpirits*; her *ſtrength*, in a week, was alſo ſo much reſtored that ſhe could with eaſe walk five miles, when before it was quite a fatigue to walk one. I can with pleaſure likewiſe add, that what alarmed us both—the *coldneſs* of her extremities, and *blackneſs* under the finger-nails—are both entirely removed, and her nails now appear healthy. As my wife has not enjoyed ſuch good health for ſeveral years as ſhe has experienced theſe laſt ſix months, Mrs. R. unites with me in grateful acknowledgements to you.

And I remain, dear ſir, your's reſpectfully,

M. ROBINSON.

Obſervations. This lady, reſiding in a country ſeat, which has a delightful garden, and a good deal of ground attached to it, in an open ſituation, could not be ſuppoſed to want vital air in the blood. Such, however, appeared to be the fact. In ſuch caſes I find by the eudiometer, that *the blood is in fault*, attracting but ſlowly into its boſom the vital principle. But as even the moſt apparently incombuſtible bodies readily deflagrate in pure oxygen air, as ſteel, &c. the ſame phenomenon might be expected in the human frame; and in the preſent inſtance we ſee that this was actually performed. The good, however, of a temporary inhalation of a ſuper-oxygenated air would have been loſt, unleſs the blood had been altered. Steel was therefore enjoined, together with what is ſtyled the phlogiſtic regimen; and the event exactly correſponded with my expectations—the radical defect was obviated, the attractive power in the blood was improved, and the blood, coming into contact with a ſuper-oxygenated atmoſphere, readily imbibed a large proportion of vital air. The blackneſs under the finger-nails in conſequence ſoon diſappeared, the appetite became quickened, the ſpirits were increaſed, and the blood freely paſſing from the centre to the circumference, and from the circumference back again to the heart, the phlogiſtic particles decompoſing the vital air in the blood in its paſſage, hence the extremities, and the whole body, became permanently warm. —As the above caſe may ſeem to ſome not ſufficient to argue much in favour of pneumatic medicine, I ſhall beg leave to lay before the philoſophic world the following extraordinary cure:

A CASE OF MELANCHOLIA.

Mr. Blundel, æt. 49, a wholeſale linen-draper on Holborn Hill, was ſubject to melancholia above thirty years; that is, he had frequent depreſſion of ſpirits, without any aſſignable cauſe; and this lowneſs was not caſual, but would remain for months with great languor, and was accompanied frequently with a diſtaſte of every thing before agreeable,

able. Mr. Blundel's only relief was a journey into the country, which he was accuſtomed to take every year. Having two very eminent phyſicians as half-brothers, the celebrated chemiſt Dr. Bryan Higgins, and Dr. Haighton phyſician to the Eaſtern Diſpenſary, the moſt eminent phyſiologiſt of this country, every thing that the art of medicine could do had been employed, but without any material advantage. Mr. Blundel wiſhed, therefore, to make trial of the vital air; and he inhaled it at firſt under the management of a ſelf-taught genius, his neighbour Mr. Varley, of Hatton-Houſe, Hatton-Garden, and found at that time "an increaſe of ſtrength" and "his ſpirits mended." But what ſtruck him moſt was, "an iſſue which uſed to diſcharge was, ſince his commencing the air, completely dried up. Another thing he remarked, "that after walking he had varicoſe tumours in the veins of his legs; but that theſe did not appear, even after a long walk, ſince he had inhaled the vital air." I will ſelect a few more obſervations, as made by Mr. Blundel.

"September 20. Spirits much enlivened after taking the vital air.

"September 22. The ſame good ſenſations have continued, although I did not take the air yeſterday.

"September 23. Found my mind tranquillized, and ſomewhat elated towards evening; and when I awoke the next morning, perceived a general glow over the body; the feet, which uſed before to be always cold, were comfortably warm; the fingers glowed to their extremities, and I could claſp them with firmneſs; before, they would feel cold and numbed, and I was obliged to rub them before I could cloſe them. All my family obſerve that my countenance looks leſs ſallow.

"September 25. Spirits continued throughout the day very good. Sleep grateful.

"September 26. The ſame to-day.

"September 27. The ſame obſervations to-day."

I ſhould mention, that when Mr. Blundel applied to me, I deſired him to continue the air with Mr. Varley, and ordered

dered a ſeton in the neck, as the iſſue was dried up. I directed alſo bark, columbo, and prepared kali, to correct acidity and brace the ſtomach, as alſo to render the blood more attractive of oxygen, and the body was kept regular with aloetic pills; and this plan ſpeedily produced the bleſſing of ſound health, which has continued now upwards of fifteen months, without any diſagreeable nervous ſenſations, and without a ſingle excurſion being made into the country.

Obſervations on this Caſe. In the caſe of Mr. Ruſſel, which was melancholia, recorded by Dr. Beddoes, the cure was effected without a ſeton; how much are we therefore to attribute to this application in the preſent inſtance? The drying up the iſſue by the vital air, when employed alone, did it not denote, from the abſorption of this principle, an increaſed energy of the abſorbents? I have before noticed, that where ſerum was diſcharged, this has happened; but when matter is ſecreted, there is on the contrary a more abundant diſcharge, or the ſerum is converted into laudable pus. In the caſe of Mr. Fixſen, St. Anne's-Street, Weſtminſter, an iſſue which could not be made to diſcharge, began immediately to pour out matter, upon the commencement of the inhalation of the medicinal air. The varicoſe veins diſappearing was a ſtrong mark of increaſed energy in the circulating veſſels. The numbneſs of the fingers going off, ſhewed increaſed action remote from the heart; the glow, the increaſe of ſpirits, all declare in marked expreſſions the influence of vital air; and what makes me the more inclined to this opinion is, that *country air* before uſed to afford the only relief.

XIV. *Account of the New Machine invented by the late Mr.* CUSTANCE, *for making Vegetable Cuttings for the Microſcope. Communicated by* Dr. THORNTON, *Lecturer on Medical Botany at Guy's Hoſpital, &c. &c.*

THE firſt idea of making vegetable cuttings to be examined by the microſcope, originated from the famous

Dr.

Dr. Hooke above a century ago, as may be ſeen in his Micrographia.

"Charcoal, or a vegetable burnt black," ſays this eminent philoſopher, "affords an object no leſs pleaſant than inſtructive; for if you take a ſmall round piece of charcoal, and break it ſhort with your fingers, you may perceive it to break with a very ſmooth and ſleek ſurface, almoſt like the ſurface of black ſealing wax: this ſurface, if it be looked on with an ordinary microſcope, does manifeſt abundance of thoſe pores, which are alſo viſible to the eye in many kinds of wood, ranged round the pith, both in a kind of circular order, and a radiant one. Of theſe there are a multitude in the ſubſtance of the coal, every where almoſt perforating and drilling it from end to end; by means of which, be the coal ever ſo long, you may eaſily blow through it; and this you may preſently find, by wetting one end of it with ſpittle, and blowing at the other.

"But this is not all: for, beſides thoſe many great and conſpicuous irregular ſpots or pores, if a better microſcope be made uſe of, there will appear an infinite company of exceedingly ſmall and very regular pores, ſo thick and ſo orderly ſet, and ſo cloſe to one another, that they leave very little room or ſpace between them to be filled with a ſolid body; for the apparent interſtitia, or ſeparating ſides of theſe pores, ſeem ſo thin in ſome places, that the texture of a honeycomb cannot be more porous: though this be not every where ſo, the intercurrent partitions in ſome places being very much thicker in proportion to the holes.

"Moſt of theſe ſmall pores ſeemed to be pretty round, and were ranged in rows that radiated from the pith to the bark; they all of them ſeemed to be continued open pores, running the whole length of the ſtick; and that they were all perforated, I tried by breaking off a very thin ſliver of the coal croſs-ways, and then with my microſcope diligently ſurveying them againſt the light, for by that means I was able to ſee quite through them.

"Theſe pores were ſo exceedingly ſmall and thick, that in a line of them, $\frac{1}{15}$ part of an inch long, I found, by numbering them, no leſs than 150 ſmall pores; and therefore, in a line of them an inch long, muſt be no leſs than 2700 pores; and in a circular area of an inch diameter, muſt be about 5,725,350 of the like pores; ſo that a ſtick of an inch diameter may containe no leſs than ſeven hundred and twenty-five thouſand, beſides 5 millions of pores, which would, I doubt not, ſeem even incredible, were not every one left to believe his own eyes. Nay, having ſince examined cocus, black and green ebony, lignum vitæ, &c. I found that all theſe woods have their pores abundantly ſmaller than thoſe of ſoft light wood; in ſo much that thoſe of guajacum ſeemed not above an eighth part of the bigneſs of the pores of beech, but then the interſtitia were thicker; ſo prodigiouſly curious are the contrivances, pipes, or ſluces by which the ſuccus nutritius, or juyce of a vegetable, is conveyed from place to place."

He afterwards ſays, "I took a good clear piece of cork, and, with a pen-knife ſharpened as keen as a razor, I cut a piece of it off, and thereby left the ſurface of it exceeding ſmooth; then examining it very diligently with a microſcope, methought I could perceive it to appear a little porous; but I could not ſo plainly diſtinguiſh them as to be ſure that they were pores, much leſs what figure they were of: but judging from the lightneſs and yielding quality of the cork, that certainly the texture could not be ſo curious, but that poſſibly, if I could uſe ſome further diligence, I might find it to be diſcernible with a microſcope, I, with the ſame ſharp pen-knife, cut off from the former ſmooth ſurface an exceeding thin piece of it; and placing it on a black object plate, becauſe it was itſelf a white body, and caſting the light on it with a deep plano-convex glaſs, I could exceeding plainly perceive it to be all perforated and porous, much like a honey-comb, but that the pores of it were not regular; yet it was not unlike a honey-comb in theſe particulars."

This is the firſt rude hint reſpecting the mode of cutting of vegetables, ſince which time cutting machines have been contrived by ſeveral ingenious mechanics, that might better perform this delicate operation. In 1770 Dr. Hill publiſhed a treatiſe, in which he explained the conſtruction of timber by means of vegetable cuttings examined by the microſcope; and he in that work gives an account of a cutting engine, in which a ſpiral knife is employed; the invention, he ſays, of Mr. Cummings. The late Mr. Adams, optician in Fleet-ſtreet, appears to have contrived a machine for cutting thin ſections of wood, in order that the texture thereof might be more viſible to the microſcope; and in his Eſſays on the Microſcope, he ſays, that this his invention was afterwards improved by Mr. Cummings. Notwithſtanding the application of Dr. Hill, and of others who attempted to bring this art to perfection, Cuſtance, a common carpenter from Ipſwich, ſurpaſſed every other, and, as Mr. Adams juſtly obſerved, continued unrivalled in his dexterity of preparing thin ſections of wood, having brought this art to the higheſt perfection. He cautiouſly kept his method a ſecret from every one, and various conjectures were made in what way he accompliſhed his unrivalled cuttings. When he was alive, I offered him fifty pounds for the diſcovery, to diſcloſe it to the world for the promotion of ſcience, and in order the better to accompliſh my views in my New Illuſtration of Linnæus; where the organiſation of vegetables is a particular object of conſideration *. When preſſed, he offered me the diſcovery for an hundred guineas; which thinking exorbitant, I gave up all thoughts of it; but, ſoon after dying, he left in his will, that every thing he poſſeſſed ſhould be put up to public auction; and, among other things, his invention of the cutting engine was particularly noticed in the catalogue. They were not, however, expoſed to examination, but I did not fail being at the ſale to embrace this opportunity of bidding for the two engines, fearful that a mo-

* Repreſentations of all the Cuttings of Cuſtance will be given in this Work.

nopoly might be made of the art of preparing vegetable cuttings, as had been ſucceſsfully done by Cuſtance. Although the oppoſition was ſtrong, I was the ſucceſsful bidder, and became poſſeſſed of both engines, which are conſtructed nearly upon the ſame principle; and I am happy to embrace the preſent opportunity of communicating to the public ſo valuable an acquiſition to philoſophy and ſcience.

Cuſtance's beſt Cutting Engine deſcribed.

Fig. 1. repreſents a view, and fig. 2. a ſection, of the cutting machine. It has the appearance of an oblong box, and the ſides from the bottom A (fig. 2.) up to B are made of braſs. A piece of hard mahogany, C C, is fitted into the braſs box, and fills the whole cavity down to *a a*, leaving a void ſpace at the bottom, of ſufficient ſize to admit the parts of the machine which work there, and which are deſcribed below. From the top to the bottom of the wood there is a perforation, of which the outline of fig. 3. may be conſidered as repreſenting a horizontal ſection, which receives eaſily a braſs ſocket, fig. 3, in which the wood (*b*) to be cut is ſecured in its place by means of a braſs holdfaſt *c*, grooved like a float file, and preſſed againſt the wood by the ſcrew *d*. This ſocket, with the holdfaſt, (which viewed in front has a fluted appearance) and the piece of wood is repreſented in its place D, fig. 1 and 2, where it is ſecured from ſhaking by means of the piece *e*, fig. 2, preſſed againſt it by the ſcrew *f*, but not ſo tight as to prevent its being raiſed when required by the micrometer ſcrew to be yet deſcribed. The ſocket, which fills the perforation from the ſurface D down to *g*, has a horizontal diviſion at *h*, which ſerves as a bottom for the holdfaſt to reſt on; the cavity of the ſocket below *h* receives a piece of metal *i i*, of which fig. 4, is an horizontal ſection; through this piece, which moves eaſily up or down in the ſocket, is a female ſcrew, in which the micrometer ſcrew turns, which may be ſeen paſſing through *i i* in fig. 2. The micrometer ſcrew, the neck of which works in a plate *m m*, made faſt to the bottom of the piece of mahogany before deſcribed by means of the

ſcrews

ſcrews *n n*, is prevented from riſing or falling, when turned round, by a conical ſhoulder fitted into the upper ſide of the plate *m m*, as may be ſeen in the figure, and by the micrometer index wheel *o o* made faſt to that end of the ſcrew which projects through the lower ſurface of *m m*. Therefore, when the index is turned, the ſcrew working in *i* raiſes or lowers *i*; the latter by its form being prevented from turning with the motion of the ſcrew. The piece *i*, being thus raiſed as much as the intended thickneſs of the ſlip to be cut, preſſes as it riſes againſt the diviſion *b*, and by that means makes the braſs ſocket, in which the wood is made faſt as before deſcribed, to riſe exactly the ſame quantity—care being taken to regulate the preſſure communicated by the ſide ſcrew *f* in ſuch a manner as juſt to allow free action to the micrometer ſcrew, and yet to prevent any lateral deviation in the aſcent of the ſocket. A portion of the index wheel comes through the front of the machine (*o*, fig. 1.); and all that is neceſſary to raiſe the wood, the parts being previouſly adjuſted in the manner deſcribed, is to lay hold of the knob that preſents itſelf at the opening, and move it to the left, a half, a whole, or two diviſions, according to the thickneſs the ſlip is wiſhed to be cut. Theſe diviſions are marked on the circumference of the index, and you note the quantity that paſſes a ſtationary point marked over the centre of the opening.

The cutting apparatus is conſtructed in the following manner:—On the further edge of the upper ſurface of the box, a flat rule, G G, fig. 1, made of ſteel, is faſtened down by the ſcrews *k k*: it is more than an eighth of an inch in thickneſs, and the front edge of it is ground perfectly ſtraight, and ſtands at a right angle to the ſurface on which it reſts. Another flat rule, one end of which, H, may be ſeen projecting paſt the end of G towards the left, ſerves as a bed for the cutting knife *r r*, which is made faſt to the rule by the ſcrews *s s*. The upper and under ſurface of this rule are ground parallel to each other, and its back edge is ground ſtraight to

fit againſt the front edge of the rule G G. The rule H, which is moveable with the knife *r r*, is tapered from the end H, ſo as to be ſomewhat narrower at the end next to the cavity D, than the diameter of the pieces of wood that can be contained betwixt the holdfaſt (*c*, fig. 3.) and the other ſide of the ſocket. From this the wonderful ſimplicity and accuracy of the proceſs, as performed by this apparatus, muſt be obvious; for the ſocket, or in other words the piece of wood from which the ſlip is to be cut, being raiſed to the deſired height by turning the micrometer *o*, all that is neceſſary is to ſlide the rule H, with an even hand and preſſure, along between the rule G G and the wood to be cut; the taper form of the knife, or rather of its bed, cauſing it to ſhave off, as the broad end comes nearer to the ſocket, a ſlip from the ſurface expoſed to its action. It ſhould be here remarked, that a portion of the bed (the rule H) is cut away from under the knife, from *r* to *r*, to allow the knife to paſs freely over the wood as it performs its office. To keep the wood perfectly faſt in its place while the ſlip is cutting off, beſides the holdfaſt in the ſocket already deſcribed, there is the following contrivance:—A braſs ſpur, *u*, a little thinner than the rule H, having a circular notch at its wideſt end, which may be moved or made faſt at pleaſure by means of the ſcrew *v*, is brought up tight againſt the wood to be cut (the wood being embraced by the circular notch), and then ſcrewed faſt; the opening at the narrow end of the ſpur, through which the ſcrew paſſes, is in the form of a ſlit, to allow it to be adapted with eaſe to different ſizes.

As the braſs ſocket riſes as well as the wood, (and this is indiſpenſible to ſecure the parallel riſing of the wood after each cut,) it muſt be obvious, that when, by being raiſed to allow taking off repeated cuttings, it has been brought almoſt to the knife, the apparatus muſt be re-adjuſted, and the wood raiſed in the ſocket before more cuttings be taken off.

It need hardly be remarked, that the cutting knife is ground

ground to a perfect true and fine edge, without warp or bend, that it may move through a perfect plane. The accuracy and delicacy with which it works may be judged by fig. 5, which represents a microscopic view of a cutting made from so fragile a substance as a *piece of charcoal*.

XV. *Remarkable Instance of a Turkey Cock hatching Eggs.* *By* M. Oedmann. *From* New Transactions of the Academy of Sciences at Stockholm. *Vol.* X.

MALE fowls, which associate with a plurality of females, care so little for their posterity, particularly in a wild state, that they do not seem to have the least affinity to the young when hatched, and contribute neither towards rearing nor protecting them; on this account M. Oedmann considers the following circumstance to be very singular; such, perhaps, as was never before observed. In the month of May 1789 a turkey-hen was sitting upon eggs, and as the cock, in his solitude, began to be uneasy and to seem dejected, he was allowed to remain in the same place along with her. He immediately sat down by the female, and people at first believed that this was only a piece of gallantry; but they soon found that he had taken some of the eggs from under the hen, which he covered very carefully with his body. The maid, who looked after the poultry, thought this mode of hatching would be attended with little advantage, and therefore put the eggs back under the hen; but the cock was no sooner at liberty than he again carried some of them away as before. M. Haselhuhn, the proprietor, when he observed this, resolved, for the sake of experiment, to let the cock have his own way, and he caused a nest to be prepared with as many eggs as the animal's large body was able to cover. The cock seemed to be highly pleased with this mark of confidence, sat with great patience on the eggs, and was so attentive to the care of hatching them that he scarcely took time to go in search of

food. At the proper period 28 young ones were produced; and the cock, who was now in ſome meaſure the mother of ſo numerous an offſpring, appeared a good deal perplexed when he ſaw ſo many little animals pecking around him and requiring his continual vigilance; but as it is well known that turkeys are ſo ſtupid and heedleſs that they often do not ſee where they tread, it was not thought proper to truſt the cock with this young brood any longer, and they were reared in another manner. M. Carlſon remarks on this circumſtance, that the total neglect of their young, aſcribed to male birds which aſſociate with a plurality of females, is not general. Geeſe are of this kind, and yet the gander protects the young with the greateſt care. But the inſtance of a turkey-cock ſitting on eggs ſeems the more ſingular, as both in a wild and a tame ſtate the males are accuſtomed to deſtroy the neſts of the females, in order that they may have them ſooner free for pairing; and for this reaſon the cock is carefully ſeparated from the hen while ſhe is hatching. The inſtance related by M. Oedmann is, therefore, the more remarkable.

XVI. *Method of ſecuring Trees from the prejudicial Effects of Froſt.* *By* P. J. B. DI SANMARTINO. *From* Giornale Encyclopedico di Vicenza.

THE ſureſt and moſt proper method of protecting trees from the deſtructive influence of froſt, is without doubt that which nature itſelf preſents, and which requires to be only a little aſſiſted by art; that is to ſay, you muſt deprive the tree, which you wiſh to defend from the froſt, of all its leaves, at a period ſomewhat earlier than the time when they would drop of themſelves. The ſap then will be leſs accumulated in the veſſels; it will circulate more ſlowly, and at the ſame time become thicker. In that caſe it will not freeze ſo readily,

and even if it does freeze, its volume will not be enlarged ſo much as if it were thinner. M. Strömer made ſome experiments which ſeem to confirm the truth of this obſervation. He plucked the leaves from a few tender branches of a tree before the uſual time of their falling; and the conſequence was, that the branches thus ſtripped withſtood a conſiderable degree of froſt without ſuſtaining any injury, while thoſe which had not been deprived of their leaves artificially were deſtroyed. It is to be obſerved, however, in regard to this experiment, that all the leaves of the tree muſt not be pulled at the ſame time, but at three or four different periods ſome weeks diſtant from each other, yet in ſuch a manner that the laſt of the leaves be removed before the uſual time of their falling. Were they all pulled off at the ſame time, a ſudden ſtoppage of the circulation of the ſap would be occaſioned, which would expoſe the tree to ſlow but certain deſtruction *.

* The following method of ſecuring the bloſſom of fruit-trees from being damaged by early froſts, is mentioned in the Memoirs of the Royal Society of Agriculture of Paris. A rope is to be interwove among the branches of the tree, and one end of it brought down ſo as to be immerſed in a bucket of water. The rope, it is ſaid, will act as a conductor, and convey the effects of the froſt from the tree to the water. This idea is not new, for the following paſſage may be found in Colerus: "If you dig a trench around the root of a tree, and fill it with water, or keep the roots moiſt till it has bloomed, it will not be injured by the froſt. Or, in Spring, ſuſpend a veſſel filled with water from the tree. If you wiſh to preſerve the bloom from being hurt by the froſt, place a veſſel of water below it, and the froſt will fall into it." See his *Hauſbuche* Wittenberg, 1608, 4to. vol. ii. p. 131; or the folio edit. of Franckfort, 1680, book vi. chap. 12, p. 203. EDIT.

INTELLIGENCE

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

DENMARK.

THE Royal Academy of Sciences at Copenhagen, in conſequence of Thot's and Claſſen's Inſtitutions, have propoſed the following queſtions as the ſubjects of prizes:

I. For Thot's institution.

The Society invites all thoſe competent to the taſk, its preſent members excepted, to tranſmit to it a complete eſſay, founded on experience, reſpecting any point of agriculture, to be choſen at pleaſure, ſuch for example as improving the cultivation of corn land, meadows, paſture grounds, or the planting of timber. It would give the Society particular pleaſure to receive complete anſwers to the following queſtions.

1. A catalogue, with the botanical and provincial names, of the different weeds, ſuch as the common corn-marygold, dog's-graſs, vetches, &c. which are found among the various kinds of grain, in any of the provinces ſubject to the Daniſh government; together with methods by which each of theſe weeds may be moſt effectually extirpated, and with the leaſt expence.

2. A circumſtantial account of the beſt proceſs by which poor or unfruitful ſoil, of a determined quality, may be ſo far improved as to be fit for cultivation; together with an eſtimate, calculated on an average of ſeveral years, of the expences and of the profits to be expected.

3. A proper deſcription of the different varieties of potatoes, which, in proportion to the length of the ſummer in Denmark, Norway, the Feroe iſles and Iceland, might be planted with the greateſt advantage; which can afford the beſt nouriſhment for men and cattle, and whether, when uſed in moderation, they are found and wholeſome food?

4. A deſcription of the different kinds of oats, and their common varieties. Which of theſe, conſidering the difference in the richneſs of the ſoil, and the greater or leſs care poſſible to be employed in cultivating them, will be moſt beneficial to the Daniſh provinces?

The papers muſt contain a clear botanical definition of the kinds mentioned. It will alſo be agreeable to the Society, if the author ſend drawings of the varieties of the oats.

5. Though the Royal Chamber of Finance ſet on foot the planting of young timber on the moors of Jutland, and the Economical Society encouraged that undertaking by premiums and other inducements, the Society does not think the following queſtion ſuperfluous: What means can be propoſed for raiſing plantations of trees with the leaſt expence, and in the ſureſt and moſt certain manner, on the heaths, moors, and other places unfit for corn land or meadows?

6. What are the kinds of graſs, beſides red clover and rye-graſs, which can be uſed in Denmark for ſowing in the fields and for improving the paſtures?

The author muſt give ſuch a clear deſcription of theſe productions as may be intelligible to farmers, together with the Daniſh and Linnean ſyſtematic names, and ſubjoin the different Daniſh appellations under which they are known to the country people. He muſt deſcribe alſo the method of cultivating each kind; and if the plant be delineated in the *Flora Danica*, he muſt refer to the figure. He muſt likewiſe give the method of cultivating each plant; and where that is unknown, by deſcribing its duration, the time of its blooming, the period of its maturity, and the ſoil it requires, endeavour to render the farmer capable of cultivating it.

7. The

7. The Agricultural Society long ago recommended the white hawthorn, buckthorn, barberry, hazel, crab-apple and willow for quickſet hedges; but as all theſe are not proper for the ſame ſoil, and as there is great want of quickſet hedges in the ſtoney, ſandy diſtricts expoſed to the wind, becauſe people are not acquainted with the kinds of trees that can be uſed, or with the method of planting them, though we poſſeſs indigenous as well as foreign trees of the buſh kind, which in this reſpect have been either tried in ſome places or may be recommended, the Society requires to know which of the tree or buſh kind, conſidering the different ſoils and diſtricts of Denmark, can be employed with the greateſt advantage for quickſet hedges, and what is the beſt method of planting them?

The author muſt give, along with the common and beſt known kinds, the Daniſh ſyſtematic names; thoſe leaſt known he muſt briefly deſcribe, and in ſuch a manner as to be underſtood by farmers. In both caſes he muſt give all the Daniſh trivial names, and the Linnean ſyſtematic appellation of each kind, with a reference to the figure in the *Flora Danica*, if it be there repreſented. The obſervations on the utility of each kind of wood for quickſet hedges, and the method of planting it, together with the determination of the ſoil which it requires, muſt reſt upon the grounds of certain experience.

Each of the papers on theſe ſubjects will be rewarded by the Society, in proportion to its novelty and the importance of the obſervations it contains, with 100 dollars; but the beſt and fulleſt, when more than one are tranſmitted, with 200 dollars.

II. For Classen's institution.

1. The inventor or improver of the moſt uſeful and beſt machine which can be employed, with moſt advantage, in agriculture, manufactures, or the mines in the Daniſh European

ropean poſſeſſions, will be rewarded by the Society with 200 dollars. The papers muſt be accompanied with proper models or accurate drawings.

2. For the conſtruction of harneſs, by which horſes, without being confined or hurt, may be able to draw in the eaſieſt manner, particularly when employed in agriculture, as in ploughing, harrowing, rolling, drawing corn-carts, &c.; and alſo in more laborious works, ſuch as drawing ſtone-carts, waggons, cannon, &c.; the Society will beſtow a reward of from 100 to 200 dollars, in proportion to the importance of the propoſed improvements.

The author muſt write his name and place of abode in a ſealed note, inſcribed with ſome device; and the papers with the ſame device muſt be tranſmitted, poſt paid, before the end of June 1799, to Profeſſor Abildgaard, ſecretary to the Society.

HOLLAND.

The ſecond Teylerian Society have propoſed the following prize queſtions for the year 1799:

As it is of great importance towards the improving and extending every branch of phyſics that the preſent ſtate of our knowledge in that reſpect ſhould be aſcertained, and that every thing which has been ſufficiently proved by experience ſhould be accurately diſtinguiſhed from what may be conſidered only as conjecture, the Society requires to know what is the preſent ſtate of our knowledge in regard to the aqueous vapours of the atmoſphere?—How far can we explain, on well founded experience, by what cauſes water is received into the atmoſphere in the form of vapour, or in any other manner, and retained there; and to what cauſes is it to be aſcribed that the water retained in the atmoſphere is diſengaged and falls down under different forms? Moreover, can all aqueous vapours be aſcribed merely to the diſengagement of the water in the atmoſphere, or have any obſervations

tions been made which clearly ſhew that water ſometimes is produced in the atmoſphere?

The Society will reward the author of that paper which ſhall treat this ſubject in the cleareſt manner, and throw moſt light upon it, with a gold medal of the value of 400 florins.

The anſwers muſt be written in the Dutch, Latin, French, Engliſh or German (but not with German characters) in the uſual manner, and tranſmitted with a ſealed note containing the name of the author, to the houſe of the Teylerian foundation at Haarlem, before the 1ſt of April 1800, that the prize may be adjudged before the 1ſt of November the ſame year.

As no anſwer was tranſmitted before the fixed period to the phyſical prize queſtion for 1797, the Society have thought proper to propoſe it a ſecond time. The prize is a gold medal of the ſame value as the above. The queſtion is as follows:

What certain knowledge have we reſpecting the nouriſhment and growth of plants; or how far can we at preſent conclude, from certain and deciſive experiments and obſervations, what the ſubſtances or principles are which chiefly afford nouriſhment to plants, and how they receive, ſecrete, and aſſimilate them?—What circumſtances relating to this ſubject, aſſerted by reſpectable philoſophers, are ſtill to be conſidered as doubtful?—By what experiments might our knowledge in this reſpect be with probability enlarged and confirmed?—And laſtly, What can be deduced from the knowledge here required reſpecting the nouriſhment and growth of plants, which might be practically applied in order to cultivate uſeful plants in many kinds of ſoil with more ſucceſs?

The chief object of the Society, in both the firſt diviſions of this queſtion, is, that the preſent ſtate of this part of our knowledge reſpecting plants may be accurately aſcertained, and that what is fully proved may be clearly diſtinguiſhed

from

from what reſts only upon weak grounds. The intention of this part of the queſtion will therefore be ſufficiently fulfilled, though the author may not be able to enrich his anſwer with new diſcoveries.

Thoſe who wiſh to become candidates for this prize muſt pay attention to ſome of the modern publications upon the ſame ſubject, and in this reſpect much information may be obtained from F. A. Humboldt's Aphoriſms drawn from the chemical phyſiology of plants *.

GERMANY.

On the 13th of January laſt the Mineralogical Society of Jena celebrated, at the ducal palace there, the firſt anniverſary of their eſtabliſhment: on which occaſion the director, Profeſſor Lenz, gave a hiſtory of the Inſtitution, and of the progreſs of the Society; M. Samuel Nagy, ſecretary of the Hungarian nation, read a chemico-mineralogical hiſtory of Hungary; M. Von Ori of Kots in Hungary, delivered a congratulatory addreſs in Latin; M. Aarn of Leibitz, in Hungary, delineated a view of the great importance of mineralogy to Hungary; Dr. Von Gerſtenberg ſhewed the influence of mineralogy on the wants of human life and the proſperity of ſociety; and M. Panſner, of Arnſtadt, gave a ſhort view of the ſuperſtitious employment of many ſpecies of ſtones in ancient and modern times.

The ſitting was cloſed by the Secretary returning thanks to the members aſſembled for the part they had taken in promoting the object of the Society; and by M. von Pazmandi, of Bong in Hungary, expreſſing his wiſhes for the future ſucceſs of the Inſtitution.

His ſerene highneſs the duke of Saxe Weimar and Eiſenach has been pleaſed to grant the Society permiſſion to hold their future ſittings in the large hall of the ducal palace,

* The title of the original is F. A. Humboldt's *Aphoriſmen aus der Chemiſchen Phyſiologie der Pflanzen.* Leipzig 1794, 8vo.

and

and to depoſit their collection of minerals and books in the muſeum of Charles Auguſtus.

In the public ſitting of March 3d, the director, Profeſſor Lenz, read a ſhort view of the lateſt diſcoveries in mineralogy; Dr. Von Gerſtenberg explained the reaſons which occaſioned the regality of mines to be eſtabliſhed; M. Panſner, of Arnſtadt, controverted the grounds adduced for the Meiſner † being of a volcanic nature; and M. Theil of Iglo, in Hungary, illuſtrated the influence which natural philoſophy has on mineralogy.

BRITISH MINERALOGICAL SOCIETY.

The want of a Society in this kingdom, whoſe attention ſhould be directed to the analyſis and reduction of our native ores and minerals, has been felt for a conſiderable time. It is with pleaſure, therefore, we announce that a Society under the above title has recently been inſtituted, which promiſes to be of conſiderable public utility; as it propoſes to analyſe, free of expence, for the proprietors of mines or landed eſtates, whatever ſubſtances they may meet with in ſufficient quantity to render a knowledge of their component parts a deſirable object. We hope, in our next Number, to be able to lay the plan of the Society before our readers.

† The Meiſner is a mountain three miles from Caſſel, which, according to meaſurement by the barometer, riſes 1959 Paris feet above the ſurface of the neighbouring river, and 2184 feet above the level of the ſea. Its upper part conſiſts of maſſes of baſaltes, ſome columns of which are 20 feet in length, and from 5 to 8 inches in thickneſs. It contains alſo coal. It has been declared to be of a volcanic nature by Faujas de St. Fond and Van Marum, who both examined it. EDIT.

MIS-

MISCELLANEOUS.

CHEMISTRY.

THE following proceſs for preparing *aurum muſivum* of a moſt beautiful quality has been announced by Brugnatelli: Precipitate a ſolution of the nitrat of tin by liquid ſulphure of potaſh, dry the precipitate and put it into a retort with half its weight of ſulphur and a quarter of the muriat of ammonia; you will then find the ſulphure of tin formed at the bottom of the retort, and of a moſt brilliant appearance.

In a former Number of this Work (Vol. II. p. 331), when laying before our readers an account of the preſent ſtate of Chemiſtry in Germany, we mentioned the favourable account given by M. Van Mons of Bruſſels, of the Elementary Treatiſe on Chemiſtry publiſhed by Profeſſor Gren, whoſe death we announced in our laſt Number. A letter which we have ſince received from M. Scherer of Weimar, ſpeaking of Mr. Gren's death and of his writings, ſays, "His Syſtem of Chemiſtry, on account of its perſpicuity and correctneſs, has obtained in Germany a decided preference over every other elementary work of the kind." This work we are happy to find has been tranſlated into Engliſh, and will ſoon be publiſhed in 2 volumes 8vo ſize. It contains all the facts relating to chemiſtry known up to 1796, as far as they come within the compaſs of an elementary treatiſe, explained on the principles of the new theory. The few diſcoveries ſince made have, we underſtand, been added by the tranſlator in occaſional notes; and, at the end, an account of the two new metals, Tellurium and Chrome.

EXCREMENT OF PLANTS.

Brugmanns, in a diſſertation on lolium * (darnel), was the firſt who proved that plants, like animals, free

* Diſſertatio de lolio, ejuſdemque varia ſpecie, noxa et uſu, 1785.

them-

themſelves from impure juices by the means of excretions *. He placed that plant in a tranſparent veſſel filled with water; and obſerved every day, at the extremity of the roots, a ſmall drop of a viſcous matter. This drop he removed, and next day there was another. All plants emit, in the ſame manner, from the extremities of their roots, and particularly during the night, ſmall drops of a liquid which is extremely prejudicial to them. It is hurtful alſo, very often, to thoſe plants which are near them; at other times it is uſeful to them: thus oats ſuffer much from the *ſerratula arvenſis*; flax, from the *euphorbia peplus* and the *ſcabious* of the fields; wheat, from the *erigeron acre*; ſarraſin, from the *ſpergula arvenſis*; and carrots, from *comfrey*.

Theſe phenomena may ſerve to explain why farmers are obliged to let their lands reſt a year; for, during that interval, this humour has time to be decompoſed. By the ſame means may be explained, why land exhauſted with one kind of plant cauſes others to vegetate with vigour: the fæces of the former hurt plants of the ſame ſpecies, and ſerve as manure to others. A field, for example, exhauſted with bearing clover, if ſown with wheat, will produce an abundant crop, becauſe the fæces of the clover are, without doubt, a manure for the wheat.

MINERALOGY.

A very ſingular ſpecies of iron ore has lately been diſcovered in Shropſhire, which may truly be conſidered as a national acquiſition. It yields, on the firſt reduction, *malleable* iron, inſtead of caſt iron, as is uſual from other ores; and the product is very large. From an hundred parts of it, previouſly torrefied, which we reduced in the aſſay furnace in the common manner, we obtained a malleable button which weighed ſixty-ſeven parts. The ſtratum, which is of

* *Plantas animalium more cacare primus exploravit vir indefeſſus Brugmanns*, ſays Humboldt in his Aphoriſms *Flora Fribergenſis*.

the

the great thickneſs of 2 feet 4 inches, was diſcovered when digging for coal.

Dr. A. N. Scherer, of Weimar, writes us, that Profeſſor Abildgaard, of Copenhagen, has lately obtained from Greenland a foſſil, which, on analyſis, is found to contain alumine in combination with the fluoric acid—a mineralogical phenomenon not before met with.

Sulphat of ſtrontian, which has hitherto been ſo ſcarce an article in this country, has lately been found in great quantities in the neighbourhood of Briſtol. It was at firſt believed to be merely a variety of ſulphat of barytes, till Mr. William Clayfield, wiſhing to obtain ſome muriat of barytes, reduced a portion of the mineral in the muriatic acid, when its great ſolubility, with its needle-formed cryſtals, ſoon indicated the preſence of ſtrontian. In the neighbourhood of Ham-green a variety of this rare production is found breaking through the ſoil in ſuch large maſſes that it has been made uſe of in mending the roads.

PHOSPHORESCENCE OF WOOD.

Dr. Carradori, in a paper on the phoſphoreſcence of wood, aſſerts that phoſphoric wood acquires by putrefaction the property of attracting and abſorbing light, and of retaining it mechanically. To make it ſhine, it is ſufficient to expoſe it for ſome time to the ſun. A bit of wood, which the author examined, continued to ſhine under oil for two whole days. In that ſituation, ſays Dr. Carradori, it was not in contact with oxygen gas.

DIURNAL MOTION OF THE EARTH.

In a work lately publiſhed, entitled, *De diuturno terræ motu experimentis phyſico-mathematicis confirmato*, with ninety copper-plates, the author, Profeſſor J. Baptiſta Guglielmi, of Bologna, giving an account of ſeveral experiments which he made on the falling of heavy bodies, ſays, that, in a height of 241 feet, he found a deviation of

8½ lines towards the eaſt, from a perpendicular direction, which amounts exactly to as much as, according to his calculation, is produced by the diurnal motion of the earth. De la Place, of Paris, diſputes a part of this deviation, and, according to his calculation, admits no more than five lines. This is adduced as a new proof of the rotatory motion of the earth.

PHYSIOLOGY.

Dr. Carradori, in a letter to M. Laſti on the digeſtion of nocturnal birds of prey, conſiders it as fully eſtabliſhed that theſe birds digeſt vegetables. It reſults from his experiments, that they can be ſupported extremely well with that food, though it is repugnant to their nature. Dr. Carradori has therefore deſtroyed the erroneous opinion that the gaſtric juice of theſe animals had an affinity only for animal ſubſtances: what he eſtabliſhes by his experiments, that carnivorous animals find nouriſhment in the produce of plants, was before rendered probable by the diſcovery made by Fourcroy of the exiſtence of gluten, albumen, and gelatinous matter in vegetables.

The ſame author has aſcertained, by new experiments, that breathing is neceſſary to aquatic frogs for the ſupport of life. He obſerved, that theſe animals held under water lived a much longer time when the jars were open than when they were ſhut, and that their exiſtence was prolonged in proportion to the volume of the air around them. Under water covered with a ſtratum of oil they lived only a ſhort time. In pure oil they died in the courſe of 40 minutes. The author was deſirous to try alſo how far water was neceſſary for ſupporting the life of theſe animals. He obſerved, that frogs kept in water up to the belly died a third ſooner than thoſe kept entirely dry. Fiſh incloſed in a jar partly filled with air, conſumed none of that fluid.

MEDICAL LITERATURE OF THE NORTH.

Profeſſor Pfaff of Kiel, and Dr. Scheel of Copenhagen, have announced a new periodical work, the object of which is to give an account of every thing that relates to the ſtate of medicine in the North, under which the editors comprehend the Daniſh States, including Holſtein, Sweden, and the northern part of Ruſſia. The work will embrace ſurgery as well as medicine, both in theory and practice; and phyſics and chemiſtry, ſo far as they are connected with theſe branches of ſcience, will not be excluded from their plan, of which the following are the outlines. 1. The theory of medicine. 2. Practical medicine. 3. Surgery and midwifery. 4. Northern medical and chirurgical literature. 5. Medical inſtitutions and medical policy of the North. 6. Intelligence. The editors have received aſſurances of ſupport from the principal phyſicians in the North, among whom are Saxtorph, Abildgaard, Calliſen, Henſler, Weber, Fiſcher, Hedin, Herholdt, &c. The editors do not mean to confine themſelves to any regular periods of publication; but will endeavour to publiſh a number, conſiſting of twelve ſheets, every three months. The firſt number was to appear at Eaſter 1799.

Dr. K. A. Rudolphi, alſo of Greifswald, has announced a work ſomewhat ſimilar, to be entitled *Swediſh Annals of Medicine and Natural Hiſtory*; two numbers to be publiſhed annually, according as materials can be procured. The editor, who was born at Stockholm, means to make extracts from every work on medicine or natural hiſtory printed in Sweden; and as a copy of every Swediſh publication of importance is procured for the academic library at Greifswald, he hopes he ſhall be able to give in theſe Annals a complete view of the preſent ſtate of medicine and natural hiſtory in his native country. The firſt part was to be publiſhed at Eaſter 1799, by Lange at Berlin.

ASTRONOMY.

The following account of the objects diſcuſſed by Lalande and the German aſtronomers, &c. who met laſt ſummer at Gotha, has been publiſhed by Profeſſor Bode of Berlin, in his Aſtronomical Almanack for the year 1801.

"In the month of January 1798, Lalande gave public notice that he intended, in the courſe of the Summer, to make a tour to Gotha, partly to ſee the celebrated obſervatory at that place, and partly to pay a viſit to his learned friend and old correſpondent Major Von Zach. On this occaſion he wiſhed, in particular, to form a perſonal acquaintance with ſeveral German aſtronomers, ſome of whom had long kept up an epiſtolary correſpondence with him; and many of them, among whom I was one, received the moſt flattering invitation to meet him.

"I reſolved to undertake this jaunt; to which I was encouraged, in particular, by M. Von Hahn of Remplin, who, however, was not able to accompany me. I accordingly obtained his majeſty's permiſſion, and having learned that Lalande, with his niece, Madame le Français, had arrived at Gotha on the 25th of July, I ſet out on the 7th of Auguſt, by Leipſig, Naumburg, and Erfurt; and on the 9th reached Gotha, where I had the pleaſure of becoming perſonally acquainted with the long celebrated and meritorious French aſtronomer and his learned niece, and of embracing my worthy friend Von Zach. At the duke's court I met with the moſt gracious reception; but the unfavourableneſs of the weather deprived me, in a great meaſure, of the ſatisfaction of uſing the noble inſtruments in the obſervatory; for, during the time which I ſpent there ſo agreeably, the atmoſphere was overcaſt, and ſtorms and rain prevailed. The aſtronomers and others preſent were: Profeſſor Klügel, Profeſſor Gilbert, and M. Piſter ſecretary of the poſt-office, from Halle; Profeſſor Seyffer, from Göttingen; M. Köhler, and M. Seyffert, from Dreſden; M. Schaubach, from Meiningen; and M. Feer architect, from Zurich. The other German

German literati who had received an invitation, ſent excuſes for not accepting it.

"Among the various aſtronomical and mathematical objects diſcuſſed on this occaſion were the following:

"Lalande wiſhed that the decimal ſyſtem ſome time ago propoſed in France to be uſed in aſtronomical and mathematical calculations, in the diviſion of time and of the circle, in inſtruments for long meaſure, in weights, coins, &c. might be introduced into Germany. We, on the other hand, repreſented to him the difficulties, in regard to common life, which oppoſed, and which would perhaps ever oppoſe, the general adoption of this ſyſtem, otherwiſe uſeful in calculation; and that men of letters were the leaſt of all fit to remove theſe difficulties: we, however, agreed that in future we would favour this ſyſtem more in our writings, in order to make it better known; and we at the ſame time expreſſed a hope that the National Inſtitute of Paris would tranſmit to us the new tables for the decimal calculation, as ſoon as they were publiſhed, which Lalande promiſed to uſe his intereſt to effect.

"He mentioned alſo the general adoption of the new ſtandard propoſed in France, called the *metre*, or the linear unity of 10,000,000 parts of a quadrant of the earth's meridian; becauſe, in his opinion, it was borrowed from nature itſelf, and therefore was equally proper for all nations. But we could give him very little hope in regard to the introduction of the metre in Germany; eſpecially as the French foot is already uſed in comparing meaſures, and its exact length every where known. We, however, reſolved to give, in future, foreign meaſures according to the metre, as we formerly gave them by the French foot, as ſoon as the exact length of the former ſhould be made known to us by the grand meaſurement now carrying on in France, but not yet completed*. We agreed alſo to give in future all calcu-

* This undertaking has been ſince finiſhed. EDIT.

lations and aſtronomical obſervations, as well as the places of the heavenly bodies in aſtronomical books, for the mean time, as ſoon as the editor of the *Connoiſſance des Tems* ſhould ſet us the example. Perhaps it will be poſſible alſo to introduce this mean time into common life, in order to effect a better regulation of the going of watches.

"Accurate and more numerous obſervations of the time of the moon's culmination were next recommended, as theſe might ſerve in determining the difference of meridians of places; alſo to inſert in aſtronomical almanacks the time of the occultation of ſtars of the fifth and ſixth magnitude, before the firſt, and after the laſt quarter of the moon, in order to give occaſion to more frequent calculations of theſe differences. In calculating the oppoſitions of the ſuperior planets, for examining the theory of their orbits, the ſame method muſt abſolutely be followed; and that given in Lalande's Aſtronomy, ſection 4162, was here propoſed.

"I produced a complete drawing of the fifteenth ſheet, and the two engraved, but not yet finiſhed ſheets, tab. 11 and 12, of my large Celeſtial Atlas, and the manuſcript of my Complete Catalogue of the Stars, and particularly the part reſpecting De la Caille's Southern Stars, which have never yet been numbered. Lalande took this occaſion to obſerve that room might ſtill be found on ſome of the celeſtial charts for new conſtellations, and wiſhed to ſee inſerted among the ſtars an aëroſtat, as the invention of the French. I embraced this opportunity, contrary to my former firm reſolution of introducing no new conſtellations, to propoſe, on the other hand, that a German diſcovery, made 350 years ago, viz. the art of printing, might be perpetuated in the heavens by ſome emblem. Both propoſals were approved. The firſt conſtellation will be inſerted between the Goat and Southern Fiſh; and the other between the Ship, Unicorn, and Greater Dog.

"Lalande was convinced, at the ſame time, by ocular demonſtration, of the accuracy of obſervations made with a Hadley's

Hadley's ſextant on the Inſels Berge, one of the higheſt foreſts of Thuringia, where the ducheſs gave a fête to the company, and where we took ſeveral correſponding altitudes of the ſun with various ten-inch ſextants by Troughton, in order to determine the time and height of the pole.

"Lalande had with him a chronometer by Berthoud the elder at Paris. The duke of Gotha has in his poſſeſſion four Engliſh chronometers, by Arnold, Emery, Mudge, &c. Major von Zach has one by Emery, and M. Seiffert of Dreſden one made by himſelf. All theſe were compared with pendulum clocks, and with each other; and their rate of going was found to be remarkably regular, which proved that they were fit to be uſed in determining the longitude. Seiffert alſo ſhewed, merely to give pleaſure to Lalande, a clock conſtructed by himſelf, according to a new invention, and having marked on the dial-plate the diurnal diviſion of the day propoſed in France. He had likewiſe with him, of his own workmanſhip, a ſtop watch with the decimal diviſion, which he preſented to Madam le Français.

"Some new inſtruments and maps were alſo exhibited and examined. Among theſe were an ocular heliometer, to be applied to a Herſchel's teleſcope, invented by M. Kohler, and conſtructed by M. Seiffert; the diaphragms of the former, for determining the ſtrength of the light of the ſtars, and his propoſed veſſel for an artificial water horizon; a map of the Rhein Thals, laid down by means of a Hadley's ſextant, by M. Feer of Zurich; ſome ſheets of the new map of the duchy of Wurtemberg, by M. Bohnenberger of Tubingen, meaſured and delineated by means of like inſtruments. The beautiful inſtruments on the ducal obſervatory of Seeberge, near Gotha, and the convenient and proper manner in which they are erected, obliged Lalande to acknowledge that he had never ſeen any where an obſervatory ſo well furniſhed.

"Of the new French calendar, and their manner of reckoning by decades, as well as their propoſed decimal diviſion

of the day, there was no diſcuſſion. Lalande himſelf muſt have been aware, that as the introduction of this innovation found, even in France, and particularly in the provinces, ſo great oppoſition, it would meet with much more in other countries. It would alſo hardly find admiſſion among thoſe who have ſtill any regard for inſtitutions which, thouſands of years ago, the firſt law-givers and aſtronomers declared to be proper for civil life, and which have ſince been retained through all ages. Beſides, this new French calendar, in making the year begin at the entrance of the ſun into the equinoctial point, determined by aſtronomical calculation, brings it back upon no ſolid and ſure grounds; while we, on the other hand, by the very ſimple method of intercalation, can determine common time backwards and forwards for many centuries, and differ only one day from aſtronomical time in the courſe of 3200 years."

The Elector of Saxony has enriched the obſervatory at Leipſic with a conſiderable number of aſtronomical inſtruments, which were before preſerved in the mathematical hall at Dreſden.

SYMPATHETIC INKS.

On this ſubject a correſpondent has ſent us the following communication:

"Many receipts have been already publiſhed for making inks, the writings with which remain *inviſible* till brought forth by heat; but many inconveniences attend even the beſt of them. Having tried all I have been able to meet with, I have found that ſome require ſo much heat that the whole paper is ſcorched before the letters make their appearance; that in ſome the letters are indiſtinct when produced; and that in others the words are almoſt legible before the heat is applied. In the courſe of my experiments on this ſubject, I hit upon a very ſimple mixture which obviates theſe inconveniences; as the writing done with it is perfectly inviſible till heat be applied, and becomes very black with ſuch a degree

gree of heat as will not injure the paper. It is alſo very durable, may be kept long before it is put to the fire, and will retain its colour long afterwards. It conſiſts of ſulphuric acid, and three times the quantity of water mixed together.

"The thing is ſo ſimple that I can hardly think it can be new: it was, however, unknown to me till I diſcovered it; and if it has not before been publiſhed, it may amuſe ſome of your readers.

"There is one inconvenience attending this ink, which is common to all of this nature: it injures the parts of the paper on which the letters are written. All theſe inks owe their property to ſome corroſive ſubſtance, which being acted upon by the fire, renders the writing viſible, by reducing thoſe parts of the paper on which the ink has been applied, to a kind of charcoal.

"*Cambridge, March* 29, 1799. J. D."

STATISTICS.

Liſt of the Births, Deaths, and Marriages, in ſeveral countries and cities of Europe, for 1798.

	Born.	Died.	Pairs married.
Abo in Sweden -	310	260	100
Amſterdam - -	6406	4769	2313
Augſburg - -	998	1163	325
Berlin - -	6206	5136	1070
Copenhagen - -	3351	3717	2238
Florence - -	3406	1696	——
Franckfort on the Mayne -	999	1002	310
Gothenburg in Sweden -	460	347	157
Groningen - -	960	646	308
The Hague - -	——	1466	563
Hamburgh - -	3512	3842	1492
Hanau - -	434	358	117
Hermanſtadt in Tranſylvania	392	374	116
Konigſberg - -	2203	2134	591

London

	Born.	Died.	Pairs married.
London - -	17927	18155	——
Magdeburg - -	1017	973	320
Mannheim - -	718	630	202
Munich - -	1682	1799	308
Pomerania, Pruſſian -	17717	11140	4349
Pruſſia, Eaſtern - -	32808	26826	8661
Rotterdam - -	1673	2025	666
Ruſſia, the Eparchy of Brazlaw excepted	991915	540390	257513
Sheffield - -	1646	1572	431
Stutgard - -	800	797	182
Thorn, Proteſtants -	179	103	139
Tubingen - -	228	146	72
Ulm - - -	570	525	169
Vienna - -	11595	13370	2765
Zealand without Copenhagen	8244	6807	——
The Dioceſe of Aarhuus -	4268	2359	1325
—— of Fühnen -	6205	4766	——
—— of Ripen* -	3851	2798	1110

Of thoſe who died at Vienna, 1309 were carried off by conſumptions, 612 by the ſmall-pox, 472 by apoplexy, &c. The births exceeded the deaths by 1775. Of thoſe born at Berlin, 3038 were males, and 2968 females; 568 were born out of wedlock: there were alſo 66 pair of twins, and one inſtance of three at a birth. Of thoſe who died, 2414 were adults, and 2722 under age.

Of thoſe born at Konigſberg, 1159 were males, and 1044 females. Of thoſe who died, 1100 were males, and 1034 females. The births exceeded the deaths by 69. Among thoſe born were 12 pair of twins, and 399 born out of wedlock. Among thoſe who died, ten were between 90 and 100 years of age; and one man had attained to his 100th: 34 perſons loſt their lives by accidents.

* Theſe three dioceſes belong to Denmark. EDIT.

Among thoſe who died in Pruſſian Pomerania were two men and three women 100 years of age, and three men and four women of from 101 to 105.

Of thoſe born in Ruſſia, 531015 were males, and 460900 females: of thoſe who died, 275583 were males, and 264807 were females. The births exceeded the deaths by 451525.

It is to be remarked here, in general, that the mortality in the Southern part of Europe is conſiderably greater than that in the Northern part, London and Copenhagen excepted. The cauſe of theſe forming an exception, is, perhaps, their being populous capitals.

MANUFACTURES.

M. Möglich, member of the privy council of Wirtemberg, lately deceaſed, found out, a little before his death, a new method of making ropes, the threads of which are not twiſted as uſual and wound round each other, but bound together ſtraight and in a parallel direction. The celebrated Muſchembroek diſcovered, by ſeveral experiments, that threads and cords, nōt twiſted, formed ſtronger ropes than thoſe which were twiſted; but he never could diſcover a proper method of uniting parallel threads together. The brothers, Landauer at Stuttgardt, have, however, begun a manufactory of this kind, which will be of great utility for ſhipping. It has been found by experiments that ſuch a rope, wove of yarn worked together, $1\frac{3}{4}$ inch in diameter, ſupported 13 hundred weight without breaking; and when it was at length made to give way by a greater weight, it broke as if it had been cut with a pair of ſciſſars; a proof that all the threads had experienced an equal degree of tenſion. A wove rope of this ſort, containing 504 threads, $3\frac{3}{16}$ inches in diameter, and 111 feet long, weighed no more than 19 pounds, whereas a common rope of the ſame dimenſions, and the like number of threads, weighed $31\frac{1}{2}$ pounds.

METEOR-

METEOROLOGY.

The ſevere cold that prevailed during the courſe of the late winter, induced the celebrated aſtronomer Lalande to publiſh, in one of the French Journals, the following liſt of years which were remarkable for the intenſeneſs of the froſt, viz. 763, 801, 1067, 1210, 1272, 1305, 1354, 1358, 1361, 1364, 1420, 1460, 1480, 1493, 1507, 1522, 1608, 1638, 1655, 1657, 1663, 1670, 1677, 1699, 1740, 1776, 1788.

ENGRAVING.

Lagarde, a bookſeller at Berlin, has begun an undertaking, never perhaps before attempted, at leaſt in Germany. He means to publiſh a Greek edition of Homer, entirely printed from copper-plates. Profeſſor Wolf, at Halle, is to ſupply the text, and the work will be executed with the utmoſt care poſſible. Jäck is to engrave the plates, from the beſt ſpecimens of Greek writing.

DEATHS.

On the 16th of December laſt, at Halle, in the 70th year of his age, John Reinhold Forſter, LL.D. profeſſor of natural hiſtory in that univerſity, member of the academy of ſciences at Berlin, and of other learned ſocieties. He was born at Dirſchau, in Weſt Pruſſia, in the month of October 1729, and was formerly a Proteſtant clergyman at Dantzig, from which he went to Ruſſia, and thence to England, where he purſued his favourite ſtudy, Natural Hiſtory. From 1772 to 1775 he accompanied Capt. Cook in his voyage round the world. On his return he reſided at London, till he was at length invited to Halle, where, for 18 years, he was a member of the philoſophical and medical faculties. Among his works are: *An Introduction to Mineralogy, or, An accurate Claſſification of Foſſils and Minerals, &c.* London, 1768, 8vo. *A Catalogue of the Animals of North America, with ſhort Directions for collecting, preſerving, and tranſporting all Kind of Natural Curioſities,* London, 1771, 8vo. *Obſervations made during a Voyage round the World, on Phyſical Geography,* &c.

&c. London, 1778. He was the author of a great many productions in Engliſh, Latin, or German, and of ſeveral papers in the Philoſophical Tranſactions. He tranſlated into Engliſh, Bougainville's Voyage round the World, and Kalm's, Boſſu's, and Reidſel's Travels. He was employed likewiſe, when in England, in the Critical Review; and he wrote various detached papers on different ſubjects, which have been inſerted in foreign Journals and the Tranſactions of learned academies. His ſon, George Forſter, who alſo went round the world with Capt. Cook, and was afterwards profeſſor of natural hiſtory at Caſſel, died at Paris, at the age of 39, on the 13th of February 1792.

Not long ago, at Hamburgh, the celebrated portrait and hiſtorical painter Hickel. He diſtinguiſhed himſelf particularly by his happy talent of giving good repreſentations of family ſcenes and children. He ſtudied at Vienna, and enjoyed there for a long time a conſiderable penſion, which Joſeph II. however at length withdrew. He reſided after this ſometimes in Swiſſerland, and ſometimes in London and Paris. The late queen of France often ſat to him, as did alſo the princeſs of Lamballe, who cauſed herſelf be painted ſometimes as a noſegay girl, and ſometimes as a fortune-teller or nun. In the year 1793 he began to paint a ſitting of the Britiſh houſe of commons, and moſt of the portraits were ſtriking likeneſſes. From this painting, which was 15 feet in breadth and 11 in height, he propoſed publiſhing a print by Cheeſeman; but, owing to ſome diſappointment in regard to the ſubſcription, the undertaking was abandoned. During the laſt days of his life he made a painting of Klopſtock, and exceedingly like. The poet is repreſented ſitting and reading one of his favourite odes. Hickel, at the time of his death, propoſed to have a print from this painting, 19 inches by 16, engraved by Huck.

At Geneva, on the 22d of January, Horace Benedict de Sauſſure, well known as a naturaliſt, chemiſt, and mineralogiſt. He was born in 1740, ſtood candidate for the mathematical

matical chair of that city in 1760, and in 1762 was appointed profeſſor of philoſophy. He was a member of moſt of the learned ſocieties in Europe, and author of many works; among which are, *Travels through the Alps*, publiſhed firſt in quarto, and afterwards in octavo; *Eſſays on Hygrometry*, *Obſervations on the Epidermis of Leaves and Petals*, &c. For a liſt of his ſmaller treatiſes, ſee Senebier's *Literary Hiſtory of Geneva*, vol. III.—M. de Sauſſure enriched natural philoſophy alſo with two valuable inſtruments, a portable hygrometer and electrometer. He had in his poſſeſſion a moſt beautiful cabinet of natural hiſtory; and an herbal, remarkable not only for the number of plants it contained, but alſo for their fine ſtate of preſervation.

On the 5th of February, at Bologna, in the 55th year of his age, the celebrated Galvani, from whom Galvaniſm, which has made ſo much noiſe in the philoſophical world, took its name. It is ſaid that a fit of illneſs, by which his wife was attacked, led him to the diſcovery of his theory reſpecting metallic irritation. The phyſician having preſcribed for his wife ſoup made of boiled frogs, Galvani, who was an affectionate huſband, prepared them himſelf; and having accidentally touched a frog after he had ſkinned it, he obſerved in it an involuntary motion, which induced him to make ſome experiments that conducted him to the diſcovery.

At Pavia, on the 11th of February, of an inflammation in the urethra, Lazarus Spallanzani, of Reggio, the celebrated natural hiſtorian.

On the 18th of February, at Leipzic, John Hedwig, profeſſor of botany, in the 68th year of his age. His reſearches reſpecting the cryptogamia claſs of plants will ſecure him immortal fame. His death will be a great loſs to the General Literary Journal of Jena, to which he was a contributor, and which was indebted to him for many intereſting communications.

On the 24th of February, at Göttingen, George Chriſtopher

pher Lichtenberg, Eſq. counſellor of ſtate to his Britannic majeſty, and public profeſſor of philoſophy in that univerſity. He was born at Ober-Ramſtadt, near Darmſtadt. On the 19th of February he read a public lecture, next day he was confined to bed, and on Sunday morning an inflammation of the breaſt put a period to his exiſtence. By this event the univerſity of Göttingen loſt an excellent teacher, and Germany one of its moſt ingenious writers, who, to profound knowledge in the moſt ſublime ſciences, united an unexhauſtible fund of original genius.

Not long ago at Paris, in the 64th year of his age, Charles Borda, an eminent mathematician, and one of the authors of the new French ſyſtem of weights and meaſures. He was a *Lieutenant de Vaiſſau du Roi* under the old French government, and with De la Crene and Pingré made a voyage to America, in order to aſcertain the utility of certain inſtruments for determining the latitude and longitude. The account of this voyage was publiſhed under his inſpection, with the title of *Voyage fait par ordre du Roi en* 1771 *et* 72, *en diverſes parties de l'Europe et de l'Amérique, pour vérifier l'utilité de pluſieurs methodes et inſtrumens ſervant à determiner la latitude et la longitude tant du vaiſſeau que des côtes, iſles et ecueils*, &c. par MM. Verdun de la Crene, Le Chev. de Borda, et Pingré, 1778, 2 vol. 4to. He was the author alſo of *Déſcription et Uſage du Cercle de Reflexion*, 1787, 4to. and of ſeveral phyſical and mathematical memoirs in different journals. He has been ſucceeded in the *Bureau des Longitudes* by C. Bougainville.

On the 7th of this month, at his houſe in Queen-ſquare, Weſtminſter, the Rev. Clayton Mordauut Cracherode, A.M. Student of Chriſt Church, Oxford, F.R.A.S. and one of the Truſtees of the Britiſh Muſeum.

Mr. Cracherode was eminent for his erudition, liberality of ſentiment, and amiable manners. His learning he decorated with a ſuperior knowledge of the fine arts; and he employed a conſiderable part of a large revenue in making collections

lections of what was beſt and moſt curious in literature and certain branches of the arts. His library is unrivalled in its kind; and his cabinet of prints, drawings and medals, is conſidered as among the moſt ſelect and valuable in a country that poſſeſſes ſo many of them.—But to his extenſive knowledge and pre-eminent taſte muſt be added the more ſolid qualities of candour, of liberality, of benevolence; and he preſented them all to the world, in which he lived at large, in the form of an accompliſhed Gentleman, heightened by the unaffected piety of a ſincere Chriſtian.

Mr. Cracherode has left a thouſand pounds to Chriſt-Church, Oxford, where he was a ſtudent; and his very rich collection of medals, and immenſe library, to the Britiſh Muſeum.

Lately, at the age of 67, John Strange, Eſq. of Portland-place, LL. D. member of the Royal and Antiquarian Societies, and of many of the learned and literary ſocieties of Europe. Mr. Strange was many years Britiſh Reſident at Venice, where, by his taſte and indefatigable diligence, he formed one of the beſt collections of pictures, particularly of the Venetian ſchool, now in England: his library alſo is moſt extenſive and ſplendid. As a naturaliſt, antiquary, and general friend and promoter of the arts and ſciences, his cabinet has always been conſidered as one of the choiceſt in the kingdom. By his will he has directed the whole to be ſold; his pictures, under the direction of Mr. Wilſon of the European Muſeum, by private contract, after being publicly exhibited; his books, by Meſſrs. Leigh and Sotheby; his prints, drawings, buſts, coins, medals, bronzes and antiquities, by Mr. Chriſtie; his cabinets of natural hiſtory, by Mr. King.—Thomas Gould, Eſq. his brother-in-law, the Rev. Edward Nares, his nephew, and Mr. Alexander, his ſolicitor, are appointed truſtees and executors.

THE

PHILOSOPHICAL MAGAZINE.

MAY 1799.

I. *Report on the Travels of* C. OLIVIER *and* C. BRUGUIERE, *undertaken by order of the French Government, through the Ottoman Empire, Egypt and Perſia, during the Years* 1792, 93, 94, 95, 96 *and* 97. *Read in the Sitting of the National Inſtitute, February* 14*th*. *By* C. OLIVIER.

IN the year 1792 the proviſional executive council, ſenſible of the advantages which might reſult to commerce, agriculture, natural hiſtory, geography, medicine, &c. by a tour through the Ottoman empire, Egypt and Perſia; perſuaded that theſe intereſting countries had never been conſidered under a proper point of view, or had been conſidered only partially, and that we had ſtill much to learn reſpecting them, made choice of C. Bruguiere and myſelf to accompliſh that object.

After ſome delays, we at length ſailed from Marſeilles, in April 1793, in a neutral veſſel, and, without touching any where by the way, arrived at Conſtantinople, after a pleaſant voyage, on the 21ſt of May.

It would be difficult to expreſs the different ſenſations excited in the traveller by the firſt view of that large city and

its inhabitants. The mixture of trees, houſes and minarets; the canal of the Black Sea, the hills and valleys by which it is bordered, Scutari and the numberleſs villages ſituated on its ſhores, the ſea of Marmora with its iſlands, Mount Olympus covered with ſnow, the variegated and fertile fields of Aſia and Europe, all together preſent ſo many pictures which at once delight and aſtoniſh. One cannot help admiring the natural beauty of the environs of Conſtantinople, and reflecting at the ſame time on the happy ſituation of that large city, which can be ſo ſpeedily ſupplied with proviſions; which is ſo eaſy to be defended, and which enjoys the advantage of a port ſo ſafe, ſo commodious, and of ſuch an extent. But if we caſt our eyes a little farther, we behold the two ſhores of the entrance into the Black Sea, for the ſpace of ſeveral leagues, convulſed by ſubterranean fires. Different ſtrata of lava, decompoſed rocks, porphyry and granites of various colours, more or leſs altered, atteſt the ſlow and ſucceſſive action of a great volcano. If we aſcend a few leagues, we diſcover, for a vaſt extent, a mine of coal, which the Turks have not yet found means to work.

We remained ſix weeks in this capital of the Ottoman empire, waiting till the envoy extraordinary of the Republic ſhould receive from the miniſter orders reſpecting our miſſion and allowance; but the attention of government was at that time engaged with objects of more importance. Our letters remained unanſwered, and we ſhould have been thrown into great embarraſſment had not our preſſing wants been ſupplied by the envoy of the Republic.

After viewing this country, ſo intereſting in every reſpect, and making an ample collection of plants, birds, fiſhes, inſects, ſhells and minerals; and after ſending two packages of ſeeds at different times to the national garden of plants, we ſet out for the Dardanelles, by which means we had it in our power either to proceed to the Archipelago in the ſpring, or to return to Conſtantinople in order to direct our courſe towards the ſouthern ſhores of the Black Sea; to proceed through

through Armenia, Georgia, Ghilan, or Chirvan, to the borders of the Caſpian ſea; afterwards to traverſe Perſia from north to ſouth, and to return by the Perſian Gulph, Buſſora, Bagdad, Meſopotamia and Aleppo. As we did not, however, hear from government, and could receive only a part of our allowance, we confined ourſelves to excurſions to different places in the neighbourhood of the ſea of Marmora, the channel of the Dardanelles, Troade, Tenedos, Scio, ſome parts of the coaſt of Natolia, Mycone and Naxia, from which we proceeded to Crete.

Agreeably to our inſtructions, we had tranſmitted to Conſtantinople, to be reared in the garden of the ambaſſador's palace, plants of a kind of apple-tree with oblong fruit of an excellent flavour, proper to be cultivated in any part of France, but more particularly in the ſouthern departments; plants of three kinds of oak not found in our foreſts or gardens—one kind proper for ſhip-building—another *à grand cupule* known in commerce by the name of *avellonée*, which is the *quercus ægilops*; and laſtly, that which furniſhes the galls of the Levant: we added alſo ſeveral ſhrubs deſtined to enrich the national garden of plants.

Though ſeveral well informed Europeans have traverſed this part of the Ottoman empire; though many of them have publiſhed intereſting obſervations on the political relations of the Turks, their manners, uſages, and religion; and though we have excellent works on the plants and ancient hiſtory of theſe countries, we, however, found that there s ſtill an abundant harveſt to be reaped, even in the beſt known part of natural hiſtory, that is to ſay, in regard to plants. But when we reflect that the reptiles, river fiſh, inſects and terreſtrial ſhells in thoſe diſtricts have not been obſerved by any traveller; that no one has made us acquainted with the riches which the Turks poſſeſs in mineralogy, mines of iron and copper, pozzolana, and coals at the very gates of the capital, marble of all kinds exceedingly abundant in the iſlands of the ſea of Marmora and the Archipelago, agates,

cornelians and chalcedonies in the fiſſures of the volcanic rocks, mines of alum and ſulphur, mineral waters of every kind; in a word, if we recollect that no traveller has conſidered this country in regard to geology, that part of natural hiſtory ſo intereſting, which by enabling us to obſerve the different ſtrata of earth and ſtones, the direction and ſtructure of mountains, and to compare the different foſſils that one meets with, muſt neceſſarily conduct to a certain knowledge of the antiquity of our globe, of the laws to which it is ſubject, and of the different cataſtrophes it has experienced, and of which ſome faint light has been tranſmitted to us by the fabulous hiſtory of antiquity, will be readily perſuaded that our obſervations, directed to theſe objects, cannot fail of being highly intereſting.

We remained four months at Candia; and though two years had elapſed ſince our departure from Paris, we had received no intelligence from government. We were, therefore, of opinion, that it would be abſolutely neceſſary for us to renounce our firſt plans; but as we were deſirous of employing our time in the moſt uſeful manner poſſible, we reſolved to proceed to Egypt, and to traverſe that country ſo abundant in ſubjects of obſervation, and as intereſting for the politician and ſtateſman, as for the philoſopher, naturaliſt and antiquarian.

The ſituation of the French in Egypt was extremely diſagreeable: their commerce had been interrupted, and they were in a ſtate of oppreſſion at Cairo. Some of them had been maltreated by the government, and the conſul of the Republic enjoyed no conſideration. Our firſt care was to ſtudy the monſtrous government of the Mamelouks, their military force and their manners; to make ourſelves acquainted with the revenues of Egypt, the preſent ſtate of its commerce, and that which it might be ſuſceptible of under a juſt and enlightened government. We examined the ports of Alexandria, the road of Aboukir, the Delta, the courſe of the Nile, its periodical inundation, the canals which the

negligence of the Mamelouks has ſuffered to be filled up, the monuments reared to gratify the pride of kings, and thoſe which have been conſtructed in conſequence of religious duties. We directed our view, at the ſame time, to the natural productions of Egypt, and thoſe which might be introduced into it by cultivation; the fertility of its ſoil, and the diſeaſes to which the inhabitants are expoſed. We enquired into the cauſe of the periodical winds. In the laſt place we examined whether the plague, that malady ſo ſudden and ſo terrible in its effects, has its ſource in Egypt, as ſome travellers have aſſerted, or whether it be there only caſual and epidemic. Our harveſt, in regard to natural hiſtory, has been very abundant: we had an opportunity of tranſmitting to the national garden of plants a third box of ſeeds from the Archipelago, Candia and Egypt.

On the 23d of March we received letters from the envoy extraordinary, by which he invited us to quit Egypt and to return to the ſhores of the Boſphorus; becauſe the time was at length arrived for carrying into effect the plans we had formed. "Regions lying farther to the Eaſt," ſaid he, "now invite you, and I wiſh to confer with you before you proceed thither."

Under the ſame cover there were two letters of C. Desforgues, miniſter of foreign affairs. One was a copy of that which the miniſter wrote to C. Deſcorches; in which he requeſted from him an eſtimate of the ſums neceſſary to be expended, in order that we might properly diſcharge our miſſion. He authoriſed him to ſupply us with whatever ſums might be requiſite, to procure ſuch guides and information as the nature of our miſſion required, and to obtain thoſe documents which were indiſpenſibly neceſſary for our reſearches and obſervations. He concluded his letter with the following words: "In all caſes theſe two obſervers of nature will be ſubordinate to your commands; they will give you an account of all their operations, and at the end of each month you will tranſmit to me the reſult of their

obſervations on the arts, ſciences, natural hiſtory, commerce, and political ſtate of the countries through which they paſs, in order that I may give a faithful repreſentation to the executive council, of their zeal, their labours, and their diſcoveries."—In the other, the miniſter informed us, that he had requeſted C. Deſcorches to give him an account of the ordinary expences to which we would be ſubjected. He concluded by deſiring us to tranſmit our ſubmiſſion in writing to C. Deſcorches, and to conform to the diſpoſitions contained in the letter which he had addreſſed to him.

We embraced the earlieſt opportunity of complying, both with the orders of the miniſter, and thoſe of the envoy. We tranſmitted our ſubmiſſion; and, having terminated our obſervations on Cairo and the neighbourhood, repaired, without delay, to Alexandria. We ſailed from that port on the 30th of April, and arrived at Conſtantinople after a navigation of forty-eight days. We had the pleaſure of touching at the iſles of Rhodes and Lero, which we had not before ſeen. The repairing of a leak in our veſſel obliged us to remain eight days at the former; and we were detained as long at the latter on account of the North winds.

During this interval C. Deſcorches had been ſucceeded by C. Verniac. We therefore delivered to the latter a ſketch of our operations, from the period of our arrival in the Levant; a ſtatement of the ſums we had received; and a minute memoir on the ſituation of the French in Egypt, the government of the Mamelouks, the productions and revenue of the country, the cultivation of the land, on its commerce, and laſtly on the improvements of which the country was ſuſceptible *. This memoir concluded with reflections excited

* The following extract from Norden's Travels, reſpecting a tradition in Egypt, that the country would be viſited by ſpies, who would report its ſtate, and at laſt bring a great number of Franks who would conquer it, may amuſe ſome of our readers, and by ſome will be thought perhaps not inapplicable to C. Olivier's miſſion, and the events that have followed it:

"January

cited by the order which C. Deſcorches had given to the conſul and French at Cairo, to repair proviſionally to Alexandria, and put themſelves under the protection of the port captain of the Grand Signior; and to wait there until more favourable circumſtances ſhould enable the conſul to reſume his functions at Cairo, and the merchants their commercial operations. We forwarded to the national garden of plants a fourth box of the ſeeds from Egypt, Rhodes, Lero, and the ſhores of the channel of the Dardanelles, as well as a live ichneumon which we had reared for four or five months.

Perſia, a prey to the horrors of civil war ſince the reigns of the latter Sophis (the family of the Sephevi), gave reaſon to hope for a flouriſhing kingdom under a monarch who had triumphed over all his rivals, and had deſtroyed each of them in ſucceſſion. The opportunity was then favourable

"January 4, 1738.—On this day (Saturday) the Daniſh traveller, Captain Norden, with his attendants, arrived at Deir, or Derri, the firſt large village or town in Nubia. The cacheff of that place, a notorious plunderer of all who fell in his power, conducted himſelf towards the travellers in ſo infamous a manner, as to oblige the captain to relinquiſh his deſign of proceeding further, and return to Cairo. When diſputing about ſome of the exorbitant demands of the cacheff, one of the company reminded him that they were under the protection of the Grand Signior. To which he anſwered in a paſſion; 'I laugh at the horns of the Grand Signior: I am here Grand Signior myſelf, and I will teach you to reſpect me as you ought. I know already what ſort of people you are. I have conſulted my cup; and I have found by it, that you are thoſe of whom one of our prophets has ſaid: That there would come Franks in diſguiſe, who, by little preſents, and by ſoothing and inſinuating behaviour, would paſs every where, examine the ſtate of the country, go afterwards to make a report of it, and bring at laſt a great number of other Franks, who would conquer the country, and exterminate all. But I will take care about that; and without further delay you muſt quit my bark.' After being plundered by him, in various ways, till the evening of the following Monday, the travellers thought themſelves very fortunate in being permitted to eſcape with their lives.—[*Dr. Templeman's Tranſlation of Norden's Travels*, 8vo. *edit.* 1757, *vol. ii. p.* 150.] EDIT.

for travelling into the interior parts of this country, ſo intereſting in every point of view. C. Verniac allowed us the whole of our appointment, authoriſed us to engage a dragoman, gave us a letter to the chief miniſter of the king of Perſia, another to the pacha of Bagdad, and, at the ſame time, various inſtructions both verbally and in writing.

At the moment of our departure, the Porte had a deſign of conſtructing in the harbour of Conſtantinople a baſon after the model of that of Toulon; and ſome Armenian merchants wiſhed to prevail on us to communicate to them a diſcovery we had made of an excellent kind of pozzolana, by offering us the ſum of 30,000 piaſtres. As we were here under the orders of the Republic, we did not think ourſelves at liberty to enter into any treaty with Armenians, in regard to our diſcoveries, until we had appriſed the envoy of the Republic. C. Verniac, who intended to get this baſon conſtructed by French engineers, deſired us to reject the offers of the Armenians, promiſing to procure us a more ample recompence from the Porte; and he immediately ſent the firſt dragoman of the legation to the Turkiſh government, to communicate our diſcovery, and make an offer of our ſervices. The Porte ſeemed to accept this offer with gratitude; and having requeſted a note on the ſubject, we embraced the earlieſt opportunity of tranſmitting to it a memoir, in which we ſaid that we had diſcovered pozzolana of an inferior quality near the channel of the Black Sea, in Prince's iſlands, and various iſlands of the Archipelago; and ſome of a ſuperior quality, or at leaſt equal to that of Italy, in the iſland of Santorin. The memoir concluded with a few details reſpecting the method of employing both.

The miniſters of the Porte, when they received this memoir, informed the dragoman, that the Armenians had demanded for the diſcovery 60,000 piaſtres, though they had offered us only 30,000. They added, that they would never forget the ſervice which we rendered to them, and that their gratitude would be boundleſs if we could effect what we promiſed.

promiſed. On this ſubject we had two interviews with the Chelebi-Effendi; and that miniſter twice gave us reaſon to hope that the Porte would reward, in a manner worthy of itſelf, the important diſcovery we had communicated.

In the mean time we were juſt on the point of proceeding on our journey to Perſia. The neceſſary preparations were already made, and we were looking out for a caravan going to Diarbekir, when the Porte required that we ſhould repair to the iſles of Santorin, Milo, and Argentiera, and tranſmit to it ſome bags of pozzolana, in order that previous experiments might be made. For this purpoſe it freighted a French veſſel, and ſent a chiaous to accompany us and bring back the ſpecimens. We were obliged to touch at Metelin to receive from the captain pacha, then lying at anchor before that iſland, the neceſſary firmans.

The inhabitants of Santorin, alarmed at this diſcovery, and fearing that the Ottoman government would cauſe the earth to be dug up at their expence, and of courſe ſend Turkiſh officers into the iſland, immediately aſſembled to execute the Grand Signior's orders, and to deviſe means for warding off the blow with which they were threatened. They thought they could do nothing better than to ſend the primates to the Latin biſhop at whoſe houſe we lodged, and to offer us a preſent if we would inform the Porte that we had diſcovered none of the above ſubſtance in the iſland. We, however, rejected the offer of theſe primates, and tranſmitted to Conſtantinople ſeveral bags filled with pozzolana of an excellent quality, which was in great abundance, and exceedingly eaſy to be dug up. We depended on C. Verniac for the promiſed recompence to which we thought ourſelves entitled by the importance of the diſcovery, by rejecting the offers of the Armenians, and the trouble, dangers, and delay we had experienced.

The iſland of Metelin, almoſt entirely volcanic, is remarkable on account of its great fertility, its immenſe ports, and its warm mineral ſprings. Argentiera, known formerly

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under the name of Cimolus, is entirely volcanic. We remarked, with pleaſure, that the Cimolean earth, which it furniſhes in abundance, is produced by a ſlow and gradual decompoſition of the porphyries occaſioned by ſubterranean fires. I collected ſpecimens of that earth in all the ſta[illegible] through which it paſſes. This obſervation will be interesting, no doubt, to mineralogiſts, and make them acquainted with the origin of a ſubſtance hitherto little known. The iſland of Milo is altogether volcanic. It preſents a vaſt port, on the borders of which is a ſpring of warm aluminous water; a very warm grotto, where feather alum is formed; a volcano ſtill burning, and a prodigious quantity of catacombs. The iſland of Santorin is remarkable for the changes effected in it by a volcano, and the ſinking down of a great part of the iſland; from which has reſulted a kind of port, more than two leagues in extent, and from the bottom of which three iſles have been thrown up at different known periods. The rupture occaſioned by the almoſt circular ſinking down of the iſland exhibits different ſtrata of volcanic ſubſtances, among which we obſerved ſeveral kinds of pozzolana. That which we ſent to Conſtantinople, and of which I have ſpecimens, may one day ſerve for ſuch maritime conſtructions as the French may think proper to make in Egypt, when they are once firmly eſtabliſhed in that country.

We touched a ſecond time at Rhodes, proceeded thence to Baruth, and afterwards to Sayd, with a view of going to Damaſcus to take advantage of the departure of a caravan for Bagdad, as we had been taught to expect; but, the caravan having departed a long time before, we were obliged to return and take the route to Aleppo. We were unwilling to quit the coaſt of Syria without paying at Tyre a tribute of admiration to which that city was ſo juſtly entitled.

As the road from Latakia to Aleppo is never ſafe, we waited ſome days for the departure of a caravan. During that time we tranſmitted to the national garden of plants a fifth

a fifth box of ſeeds, from the iſlands we had viſited, and the coaſts of Syria. On our arrival at Aleppo we employed ourſelves in examining the ſituation of the French in that city. We collected information reſpecting the commerce carried on by the Europeans with the inhabitants, and ſent to C. Verniac a memoir on that ſubject. We alſo made various obſervations in regard to natural hiſtory and geology. We procured ſeveral birds, and a few quadrupeds: after which we ſet out, towards the end of winter, in company with a caravan; and, paſſing through Orfa, Merdin, Neſbin, and Moſul, arrived at Bagdad without any accident.

(To be concluded in the next Number.)

II. *Proceſs of making Attar, or Eſſential Oil of Roſes. By Lieut. Col.* POLIER. *From the* Aſiatic Reſearches.

THE attar is obtained from the roſes by ſimple diſtillation, and the following is the mode in which I have made it.

A quantity of freſh roſes, for example forty pounds, are put in a ſtill with ſixty pounds of water, the roſes being left as they are with their calyxes, but with the ſtems cut cloſe. The maſs is then well mixed together with the hands, and a gentle fire is made under the ſtill: when the water begins to grow hot, and fumes to riſe, the cap of the ſtill is put on, and the pipe fixed; the chinks are then well luted with paſte, and cold water put on the refrigeratory at top: the receiver is alſo adapted at the end of the pipe; and the fire is continued under the ſtill, neither too violent, nor too weak. When the impregnated water begins to come over, and the ſtill is very hot, the fire is leſſened by gentle degrees, and the diſtillation continued till thirty pounds of water are come over, which is generally done in about four or five hours: this roſe-water is to be poured again on a freſh quantity (forty pounds) of roſes, and from fifteen to twenty pounds of water

water are to be drawn by diſtillation, following the ſame proceſs as before. The roſe-water thus made and cohobated, will be found, if the roſes were good and freſh, and the diſtillation carefully performed, highly ſcented with the roſes. It is then poured into pans either of earthen ware or tinned metal, and left expoſed to the freſh air for the night. The attar, or eſſence, will be found in the morning congealed, and ſwimming on the top of the water; this is to be carefully ſeparated and collected, either with a thin ſhell or a ſkimmer, and poured into a phial. When a certain quantity has thus been obtained, the water and fæces muſt be ſeparated from the clear eſſence, which, with reſpect to the firſt, will not be difficult to do, as the eſſence congeals with a ſlight cold, and the water may then be made to run off. If, after that, the eſſence is kept fluid by heat, the fæces will ſubſide, and may be ſeparated; but if the operation has been neatly performed, theſe will be little or none. The fæces are as highly perfumed as the eſſence, and muſt be kept. After as much of the eſſence has been ſkimmed from the roſe-water as could be, the remaining water ſhould be uſed for freſh diſtillations, inſtead of common water, at leaſt as far as it will go.

The above is the whole proceſs of making genuine attar of roſes. But as the roſes of this country give but a very ſmall quantity of eſſence, and it is in high eſteem, various ways have been thought of to augment the quantity, though at the expence of the quality. In this country, it is uſual to add to the roſes, when put in the ſtill, a quantity of ſandal-wood raſpings, ſome more, ſome leſs, (from one to five tolahs, or half ounces). The ſandal contains a deal of eſſential oil, which comes over freely in the common diſtillation; and, mixing with the roſe-water and eſſence, becomes ſtrongly impregnated with their perfume: the impoſition however cannot be concealed; the eſſential oil of ſandal will not congeal in common cold, and its ſmell cannot be kept under,

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but will be apparent and predominate in ſpite of every art. In Caſhemire they ſeldom uſe ſandal to adulterate the attar; but I have been informed, to increaſe the quantity, they diſtill with the roſes a ſweet-ſcented graſs, which does not communicate any unpleaſant ſcent, and gives the attar a clear high green colour: this eſſence alſo does not congeal in a ſlight cold, as that of roſes. Many other ways of adulteration have been practiſed, but all ſo groſs and palpable that I ſhall ſay nothing of them.

The quantity of eſſential oil to be obtained from the roſes is very precarious and uncertain, as it depends not only on the ſkill of the diſtiller, but alſo on the quality of the roſes and the favourableneſs of the ſeaſon: even in Europe, where the chemiſts are ſo perfect in their buſineſs, ſome, as Tachenius, obtained only half an ounce of oil from one hundred pounds of roſes.—Homberg obtained one ounce from the ſame quantity; and Hoffman above two ounces.—The roſes in thoſe inſtances were ſtripped of their calyxes, and only the leaves uſed. In this country nothing like either can be had; and to obtain four maſhas (about one drachm and half) from eighty pounds, which, deducting the calyxes, comes to ſomething leſs than three drachms per hundred pounds of roſe-leaves, the ſeaſon muſt be very favourable, and the operation carefully performed.

In the year 1787 I had only ſixteen tolahs, or about eight ounces of attar from fifty-four maunds, twenty-three ſeers (4366lb.) of roſes produced from a field of thirty-three biggahs, or eleven Engliſh acres, which comes to about two drachms per one hundred pounds.

The colour of the attar of roſes is no criterion of its goodneſs, quality, or country. I have had, this year, attar of a fine emerald green, of a bright yellow, and of a reddiſh hue, from the ſame ground, and obtained by the ſame proceſs, only of roſes collected at different days.

The calyxes do not in any ſhape diminiſh the quality of the attar, nor impart any green colour to it, though perhaps

haps they may augment the quantity: but the trouble neceſſary to ſtrip them muſt, and ought to, prevent its been ever put in practice.

III. *On Primary Ores of Iron. By Mr.* DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

PRIMARY ores of iron are ſo named in contradiſtinction to ores which appear, like iron-ſtones, to have been formed by a ſecondary agency. Their varieties are ſtill more numerous than thoſe of iron-ſtones; poſſeſſing various characteriſtic features, which amply diſtinguiſh them from each other, either in their inherent properties and effects, or in the manner of their foſſil diſpoſition. Some are obedient to the magnet, others not. This property is by no means dependent upon the quantity of iron exiſting in the ore: the ore from the iſland of Elba, ſome of which yields 70 to 80 per cent. of iron, is ſlightly obedient to the magnet: the fine hæmatites and kidney of the Cumberland ore, which yield from 64 to 70 per cent. are not, in their native ſtate, in the leaſt degree magnetic; while many of the Daniſh and Norwegian ores, containing from 18 to 30 per cent. are magnetic in a great degree. I have formerly mentioned, that where the magnetic property was inherent, it was more a proof of the exiſtence of iron, than a criterion whereby to judge of the probable quantity of metal in the ore.

The colours which primary ores of iron exhibit are alſo very various. The beautiful cryſtalliſed fractures of the Elba ſpecimens, the priſmatic colours they exhibit, the coloured oxyde depoſited in flowers upon their ſurface, and the general appearance which they have of fuſion, ſtrongly lead to a concluſion that fire has here been the immediate agent in the production of ſuch variegated forms. This concluſion is ſtill more forcibly impreſſed, after minutely examining and comparing with them thoſe very perfect cryſtals which are found

amongſt the Cumberland ores. Theſe at once convey the idea of the agency of water in their formation: if the internal cavities of ſome of the pieces are examined, the proofs multiply and become irrefragable. The chaſms in which the cryſtals are found, and always formed, diſplay the proceſs of cryſtallization in all its various ſtages. Cryſtals are found in finiſh and form proportioned to the ſtage of the operation: ſome imperfect, and of a clayey conſiſtency and colour; others in a more finiſhed ſtate, hard, but as yet unpoliſhed or diaphanous: ſome are encircled in a ſlimy membrane, which, when diſplaced, diſplays the cryſtals more or leſs tranſparent as the operation has been more or leſs perfect. I have found cavities in this ore quite filled with water, which in this ſtate had been tranſported ſome hundred miles; the ſides and bottoms of ſuch chaſms always abounding with a ſoft mud compoſed of the fineſt fragments of ſilex, free from every touch of aſperity. Again, cryſtals are found in this ore, which poſſeſs various degrees of pellucidity; ſome of them very white, yet dull; abſorbing light, yet tranſmitting little. Others are as clear and tranſparent as the pureſt water; their angles frequently decompoſing light with all the vivid effects of the priſm. Other varieties are leſs diaphanous, but poſſeſs various tinges of colour, and increaſe in opacity in proportion as the colouring matter is preſent in the cryſtal. Some poſſeſs a garnet colour more or leſs intenſe, and moſt of them tranſmit leſs or more light.

There is another variety of cryſtals among the Cumberland ore, exhibiting a green colour, which is owing to the preſence of an acid. This, like the garnet coloured cryſtal, tranſmits light in a greater or leſſer degree in proportion to the quantity of iron preſent. There are alſo various priſmatic cryſtals in this ore, of a ſmall ſize, which owe their ſplendid and variegated luſtre to ſulphur, and which are eaſily tarniſhed by the application of heat. Specimens alſo of cryſtallized iron ore, in the form of razor blades, containing oxygen and carbon, are not uncommon: theſe reſemble more the Elba ore

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than any other variety; yet, the ſtate of the carbon ſo much reſembling foſſile plumbago, ſo unlike the carbon which the Elba ſpecimens afford, and ſo widely different from that obtained by fuſion, together with the ſmallneſs and regularity of the cryſtals, their luſtre and finiſh conſtitute a wide difference between theſe two ores.

The fine red oxyde which ſo much reſembles cinnabar, and which is found in abundance upon the Elba iron ore, appears to me to be an oxyde of iron depoſited by the decompoſition of ſulphat of iron. Thus far I can ſay, that a powder exactly ſimilar was depoſited upon the ſurface of ſome iron-ſtones expoſed to a high temperature, in which I had aſcertained the preſence of the ſulphuric acid. The various ſhades of colour which appear upon the Elban ore, exactly reſemble thoſe which may be paſſed upon ore, iron, or ſteel, by expoſing them under certain degrees of heat to the action of atmoſpheric air. Its fracture is moſt evidently vitrified, and exactly reſembles iron fully combined with oxygen, afterwards reduced by fuſion to an opaque and very ponderous glaſs. Like the Elban ore, ſuch vitrifications, when broken, diſplay a perfect ſtate of cryſtallization.

I have even obtained ſpecimens of this ponderous lava poſſeſſing a variety and richneſs of colouring, equal to many of the Elban ſpecimens.

Though the agency of water will more readily explain the ſtructure, cryſtallization and depoſition of foſſils in general, yet there are circumſtances which moſt forcibly claim an exception. The Elba ore, in my opinion, is one: I conceive it to be iron oxydated in fuſion by the combination of a quantity of oxygen, from 18 to 24 per cent. incluſive of a ſmall portion of carbon, to which, either at the time, or by a ſubſequent proceſs, ſome volatile mixtures have been added. In a more proper place I ſhall minutely enter into the nature and analyſis of this beautiful ore of iron. I ſhall only here exhibit ſome ſimple reſults obtained from it when comparing it with other ores of iron.

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The form and appearance of the mafs of this ore much refembles the exceffively faturated fpecimens of crude iron and plumbago, defcribed in my paper upon the principles of iron and fteel, with an allowance in the former for its long expofure to the tarnifhing effects of water and other elements: the agency of thefe has conferred a variety of colours in flowers, though the principal colouring of the ore feems to have been the effects of oxygen combined with the iron at certain degrees of heat: in its raw ftate the magnet has little power over it. Of this ore pulverifed (which poffeffed a fine reddifh brown colour, interfperfed with fhining fpecula of magnetic iron ore, refembling plumbago produced in the fmelting furnace), I threw into an iron veffel heated to rednefs 80 grains: a gas was difengaged, which, from its fmell, I concluded was carbonic acid gas, for I had not at hand a proper apparatus or lime-water to try it with: the ore deepened during ten minutes expofure, without changing the fplendor of the fmall fpecula; when cooled, it was found to have loft 2 grains = 2·25 per cent.

I next introduced into a clofe veffel, in fmall pieces, 315 grains, and expofed them to torrefaction for four hours in a bright red heat: the refidue weighed 282; fo that there were loft of carbonic acid, and perhaps a little water, 33 grains = 10·7 per cent. The fine red, brown, and purple colours, were now totally annihilated; a flightly coloured powder was attached to the ftopper of the veffel; the ore was now of a dull blueifh colour, much frittered, granulated, but not pulverulent: the magnet in this ftate poffeffed a confiderable degree of influence over it, but by no means in proportion to the quantity of iron which it contained—not even equal to what it has on common iron-ftones: from this circumftance I inferred, that a confiderable quantity of oxygen ftill remained fixed with the metal. In order to afcertain this, I introduced the laft product, weighing 282 grains, into a clofe veffel, mixed with charcoal duft: the mixture was expofed for nearly ten hours to a bright red heat; the ore being then fe-

parated from the charcoal, washed and dried, weighed 222·5, the charcoal having taken up 59·5 grains = 21 per cent.

In this state the ore had lost all its colour, and had assumed a whitish limey tinge; had increased in bulk, and become frittered, yet possessing a considerable degree of continuity: when the smallest degree of friction was applied, the metal brightened, and shewed a beautiful disengaged state of malleable iron; the pieces easily connected under a welding heat, and received with facility impressions from the hammer; it now adhered in great abundance to the magnet. The small portion of lime, nearly equal to two parts, which was still interspersed with it, effervesced in acids; but the iron remained without exciting agitation. The practical analysis of this specimen of the Elba ore may, for the present, be thus stated:

Water, carbonic acid, and other volatile mixtures, driven off by torrefaction - -	10·7
Oxygen (taken up by the charcoal) -	21·2
Lime - - -	2
Iron - - - -	66·1
	100 parts.

The specific gravities of the various states of this ore are as follows:—In the raw state, 4·317—Torrefied, 4·000—De-oxygenated, malleable, much frittered, 2·460.

In the subsequent part of this paper, I shall confine myself chiefly to those primary ores used in Britain for the production of crude iron. The effects produced by such ores, when fused alone, are only to be learned in this country, at those iron-works where the charcoal of wood is used. The number of charcoal furnaces however are decreasing; and those at present used as such, are not supplied with wood for one-third of the year. These ores are, in the charcoal furnace, capable of producing crude iron of all the various degrees of carbonation. Since the invention of coak pig-iron, the proprietors of these furnaces have confined their manufacture

facture to the forge pig, or oxygenated crude iron, part of which is uſed to make a fine quality of bar-iron for the purpoſe of manufacturing into wire: for this end ſome of the manufacturers prefer carbonated iron, from which to fabricate their bars, in order that a great ſhare of ductility, elaſticity and ſtrength may conjointly be united. Britiſh bar-iron, thus manufactured, far exceeds the fineſt foreign marks, in its aſtoniſhing ductility in the wire-drawer's gauge.

When primary ores of iron are introduced into the pit-coal blaſt furnace, forming by weight a conſiderable proportion of the mixture, with the uſual proportion of coaks, the reſult is always oxygenated crude iron, unfit for any purpoſe but the forge manufacture. Experience, therefore, has taught the ſmelter to uſe them in ſmall quantities, proportioned to the meaſure of iron-ſtone applied at each charge of materials. Some have renounced the uſe of Cumberland and Lancaſhire ores, as being incompatible with the exiſtence of good melting pig-iron; and the advocating for or againſt their uſe is at preſent a matter of local opinion. So much is, however, decided regarding them, that primary ores of iron in any proportion will, when improperly applied, produce oxygenated crude iron; that iron-ſtone, properly proportioned with coaks, affords the fineſt quality of crude iron; and, in the iron trade, it is ſtill a deſideratum, whether Cumberland and Lancaſhire ores, when ſmelted with pit-coal, will afford in the large way a quality of pig-iron equal to that preſently made from iron-ſtone. On this intereſting ſubject I ſhall make a few obſervations. I deem it intereſting, ſince, in many places on the coaſt of Scotland, coal is to be found in great quantity, where as yet a ſufficient quantity of iron-ſtone has not been diſcovered, or which from appearances likely never may: in ſuch ſituations, favoured by a ready communication, either to import materials, or to vend raw or manufactured products, the Cumberland and Lancaſhire ores might be purchaſed and uſed with great econo-

my, provided the great end could be anſwered of obtaining from them crude iron of all the various degrees of carbonation.

Theſe ores, either in a raw or *calcined* ſtate, being much richer in iron—nearly double—than the average maſs of iron-ſtones, are in the blaſt furnace more fuſible, from their ſuperior richneſs; they deſcend ſo rapidly to the bottom of the furnace, through the ſtrata of ignited coaks, that time is not given for imbibing the carbonic principle; part of the iron is ſeparated highly oxygenated, and part of it runs off precipitated in oxygen, and united with the ſcoria or fuſed earths. When this is found to be the caſe, and which is eaſily known by the fracture, weight, and blackneſs of the lava—were the manufacturers to add a farther proportion of fuel to take up the remaining oxygen, then the whole, or nearly the whole of the metal would be revived; ſtill it would poſſeſs a white fracture. Were the Cumberland and Lancaſhire ores ſolely uſed with pit-coal, were they deprived of their iron, and again that iron revived, though poſſeſſed of a highly oxygenated fracture, the great object would be half effected; for it is obvious, that in this caſe the furnace, and the quality of iron, are in the ſame ſtate with a blaſt furnace, affording a ſimilar quality of metal where iron-ſtone and pit-coal coaks only are uſed. In the latter caſe a ſmall additional portion of fuel, per charge, enables the metal to take up a part of the carbon afforded by the fuel: the fracture of the metal is, by this combination, or mixture, changed from white to grey blue; its aſſumption of this colour is in proportion to the extra quantity of fuel. From this fact, and from the parity of ſituation, I conclude that by a ſimilar treatment—the additional fuel being always proportioned to the weight of metal in the ore—the metal of ſuch ores might be revived ſufficiently carbonated for any purpoſe; though, I queſtion not, poſſeſſed of peculiar characteriſtic properties, which would diſtinguiſh this metal; in a greater or leſs degree, from that obtained from iron-ſtones treated in the ſame manner.

Accuſtomed

Accuſtomed to apply the ores by weight, a determinate quantity is frequently introduced into the furnace without adverting to its ſuperior richneſs in iron, and the conſequent extra proportion of fuel neceſſary to take up its relative proportion of oxygen. The nature and conſequences of this will be better underſtood by the following example; firſt premiſing, that the quantity of oxygen—which is the great evil to be got rid of—exiſts in a juſt proportion to the quantity of iron. Suppoſe then a blaſt or ſmelting furnace, burdened in the following manner as to coaks and iron-ſtone: Coaks 400 lb.—Torrefied iron-ſtone of various qualities 420 = 820: let this quantity be ſuppoſed to yield in the blaſt furnace 40 per cent. then each charge will yield 168 lb. Let it alſo be ſuppoſed that this proportion of materials afforded ſuper-carbonated iron; in this caſe there was preſent, not only a ſufficient quantity of carbon to take up the oxygen contained in the ore, but ſuch an abundance as to unite with the iron and to form plumbago. Should it be wiſhed to reduce the quality, or to increaſe the quantity of the pig-iron, by rendering it leſs carbonated; and ſhould this be effected by adding to the above mixture a ſmall box of Cumberland ore containing 60 lb., then a portion of iron, with its accompanying oxygen, (ſuppoſing the ore to yield in the blaſt furnace 55 per cent.) would be thrown into the furnace equal to 33 lbs.; and the total produce of iron, per charge, would be 168 + 33 = 201 pounds, making a ſum nearly equal to $\frac{1}{5}$ of the original quantity. This portion would of courſe require $\frac{1}{5}$ of additional fuel to preſerve the original quality of the metal: it is even preſumable that the proportion of coaks increaſes in a greater ratio, owing to the ſpeedy deſcent of the ore through the furnace: this increaſe may be fairly eſtimated as 5 to 8. The quantity of fuel being now too little to take up all the oxygen, part of the metal remains unrevived, and flows out, minutely divided, and interſperſed through the ſcoria, in the ſtate of an oxyde; the ſeparated metal, deprived of its original portion of char-

coal, iſſues from the furnace highly oxygenated—a number of globules deflagrating ſo ſoon as it comes in contact with the air.

If, in order to correct the quality of the iron, a portion of the iron-ſtone is taken off = 1 box, or 60 lb. let the produce of this weight be eſtimated at 40 per cent. then the quantity of metal taken from the total 201, will be equal to 24, leaving for metal produced at each charge 177 lbs. inſtead of 168, as in the former caſe when the iron was ſuper-carbonated.—Additional quantity of metal = 9 lbs.

Quantity of concrete oxygen, reckoned at 22 per cent. nearly equal to 2 pounds weight.

Small as this quantity may appear to be, yet, on many occaſions, a furnace will not admit of the addition without altering the quality of its iron from the one extreme to the other. The manufacturer, therefore, finding his operation with ores ſo ſubtle and precarious, frequently abandons their uſe, in the firm belief that their application, in quantity, is incompatible with the exiſtence of good melting pig-iron; whereas, had the ore received a proportion of fuel adequate to its ſuperior richneſs, it is at leaſt queſtionable whether the exact ſame conſequences would have been entailed: even in the caſe of iron-ſtones, the manufacturer ought to conſider the quantity of iron contained in the ore, as alſo the nature of the various mixtures, in order to enſure to himſelf a produce of carbonated crude iron.

There are two ways which would moſt likely be attended with the happieſt effects in producing melting pig-iron from primary ores of iron with pit-coal, advantageous to individuals, and to the improvement of the buſineſs in general: the one, by a proceſs ſimilar in its principles of preparation to that at preſent practiſed for iron-ſtones; the other, by deoxygenating the ore before it is introduced into the blaſt furnace. To enſure ſucceſs in the former of theſe operations, the following requiſites would be neceſſary.

1ſt. A narrow conſtructed furnace, of an unuſual height, in

deſcending through which, the ore, previous to fuſion, would be expoſed to a long cementation in contact with the coal; by which means the carbonaceous or fuſible principle would be conveyed to the metal in quantity, and its quality thus conſtituted previous to ſeparation.

2nd. The column of air neceſſary in this caſe would require to be cool, denſe, and quickly impelled; the diameter of the diſcharging pipe not to exceed $2\frac{1}{4}$ inches, but the column of blaſt able to ſupport 6, $6\frac{1}{2}$, or 7 inches of mercury.

3rd. In the application of the ore itſelf great attention ought to be given to the quantity of iron contained, as alſo to the quantity of oxygen combined with it, in order that a quantity of coaks might be applied adequate to what a ſimilar portion of iron would require in uſing iron-ſtone.

4th. The ore ſhould be dried in a red heat, that what portion of water and ſulphur it contained might gently be diſſipated; care to be taken, however, to prevent a high degree of heat, that a greater quantity of oxygen from the atmoſphere might not be united to it.

5th. It would be highly proper to reduce the ore to ſmall pieces: this would not only greatly facilitate the eſcape of the water and ſulphur by diminiſhing the points of contact, but alſo, by expoſing a larger ſurface, enable the ore in the ſmelting furnace to take up the coally principle with greater facility; the pieces not to exceed $\frac{1}{2}$ or $\frac{3}{4}$ of an inch in their thinneſt diameters.

6th. The earthy mixtures of ores being chiefly ſiliceous, the application of pure calcareous earth as a flux or ſolvent would be requiſite; and, according to exiſtent circumſtances, a lime-ſtone, containing fine clay, ſlightly coloured by the preſence of the oxyd of iron, might be uſed: the bulk of the pieces of lime-ſtone ought alſo to be a matter of attention, and ſhould not greatly exceed the ore in ſize.

In the end, ſhould an aſſociation of theſe requiſites produce the deſired effect, and crude iron of all the various degrees of carbonation be obtained from primary ores of

iron, it would render many ſituations in this country eligible for iron-works, which are at preſent only ſo on account of the immenſe profuſion of coal with which they abound; it would call into profitable exiſtence the iron contained in theſe vaſt and extenſive mines of Cumberland and Lancaſhire; confer ſpirit and activity on the manufacturer and the landed proprietor, in a general ſearch after ſo profitable and uſeful a mineral; and would tend to throw new and ample light upon many valuable ores of various natures, which at this time lie dormant, unexplored, and unappreciated.

The ſecond method likely to ſucceed in fabricating melting pig-iron from primary ores would be to ſubject them to de-oxygenation in the moſt economical way; not ſeverely, ſo as to change them into malleable iron, but in a manner which would ſtill render them ſufficiently fuſible. The deprivation of oxygen in this manner, would enable the carbonaceous principle to take immediate effect, by penetrating the ore, and conſtituting real fuſibility: it is even probable that the quantity of fuel uſed to effect this, in ſuch ſimple conſtructed furnaces as might be found anſwerable, would afterwards be ſaved in the ſmelting furnace, and the ore rendered equally cheap in this ſtate as when raw—beſides the great point in obtaining the wiſhed for quality of iron.

The coaly matter requiſite to ſtratify the ore—previous to de-oxygenation—would be the duſt afforded by the coals in the preſent mode of coaking; and which, from the tender nature of the coal, exiſts, at ſome works, in great quantities: it is of no real value, and, by paſſing it through ſieves to render it of an equality of ſize, it might be uſed to imbed the ore without any other preparation. Such matter as this is capable of protecting the ore for a much longer time than would be requiſite in this operation: charcoal-duſt, made from pit-coal, is capable of withſtanding a heat equally violent as charcoal-duſt from wood, without being ſooner conſumed; it is even leſs liable to be deſtroyed when at

any

any time in contact with external air, either in the proceſs of cementation for ſteel, or in the de-oxygenation of iron-ores. Iron-ores thus ſtratified, expoſed to a ſtate of complete ignition, would in 8 or 10 hours nearly part with the whole amount of mixtures, including oxygen, with which they were combined; the ore would be found penetrated with a conſiderable portion of carbon, and the metal exiſting in a ſtate nearly diſengaged. Their tendency, however, would much depend upon the various mixtures which compoſed the individual ores; their loſs of weight, their properties and appearance, alſo depending upon ſimilar circumſtances with thoſe explained in the preparation of iron-ſtone in a former paper.

The varieties of the primary ores of iron found in this country are much limited, and chiefly poſſeſs the ſame external characteriſtic forms—at leaſt thoſe which have come within my knowledge—that of the iſland of Iſlay excepted. Cumberland and Lancaſhire ſeem to be the two great depoſits for this mineral. The ore of the former is found in large maſſes, ſplinty, and globulated, conſiſting of various kidney forms and hæmatites, ſtriated and ſmooth, of blueiſh and reddiſh colours. The kidneys are frequently large, compoſed of ſucceſſive layers encruſting a nucleus of coarſer ore. The ſplinty pieces are of a light blueiſh colour, and frequently afford the moſt beautiful ſpecimens of various cryſtals, principally of a whitiſh colour, of a chalky, and ſometimes of a pellucid appearance; alſo garnet, more or leſs intenſe, and green. The moſt common ſhapes are pentagonal and hexagonal pyramids, with truncated baſes. Some of theſe I have found meaſure 1 inch at the baſe: from this uncommon ſize, down to the moſt minute forms imaginable, the ſame figures are found poſſeſſing purity, tranſparency, and finiſh in the higheſt degree: theſe claſſes are of a whitiſh water colour, more or leſs pellucid. Garnet coloured cryſtals are found of the ſame ſhape, but of a very

ſmall

ſmall ſize, none of them meaſuring more than $\frac{1}{20}$ of an inch upon the baſe.

The various ſhades of garnet, yellow, and green coloured cryſtals, when found of a large ſize, have generally aſſumed the form of a priſm, a cube, or a parallelopipedon with flattened edges: none of theſe, however, poſſeſs the tranſparency of the pure quartzoſe cryſtal. The whole of theſe forms are found in chaſms in the large maſſes of ſplinty ore: when the cavity is broken up, the groups of cryſtals are found occupying all its ſides, and projecting their tops to each other. Not unfrequently cluſters of cryſtals are found imbedded in a thin ſtratum of beautifully cryſtalliſed priſmatic iron-ore, obedient to the magnet, and poſſeſſed of the moſt ſplendid dazzling colours.

The Lancaſhire ore is compoſed of ſmaller maſſes, ſofter, and of a more greaſy appearance; there are, however, in it all the former variety of cryſtals, though of a ſmaller ſize. The quality of this ore is alſo much preferred in the blaſt furnace, whether in the proceſs with pit-coal coaks, or with the charcoal of wood. This partiality is owing to the mixtures in it being more favourable to the exiſtence of carbon in the blaſt furnace: clay, and not unfrequently calcareous cryſtals, are found in this ore; whereas the earthy mixture of the Cumberland ore is chiefly ſiliceous, with a ſmall portion of ſulphur. Both of theſe ores, in the kidney variety, contain fine ſpecimens of foſſile plumbago.

In ſeveral places in Scotland iron ores have been diſcovered reſembling in point of appearance thoſe of Cumberland and Lancaſhire: ſome individual pieces as rich in iron, but the average quality, as to contents in iron, inferior. The quantity hitherto found has been ſo ſmall, and its locality ſo inſulated, that it has never been, to the manufacturer, an object of attention, nor of farther ſearch to the proprietor. In the Weſt Highlands ſome tranſient veins have been found, but their irregularity of diſpoſition has hitherto

hitherto prevented their ſource, or principal maſs, from being explored.

A vein, which indicated a large field of ſupply, was ſome years ago traced in the neighbourhood of Muirkirk iron-works, and its courſe followed for ſeveral miles. The kidney pieces of this ore are fully as rich and ponderous as thoſe of the Cumberland vein.

Saliſbury Craggs, in the neighbourhood of Edinburgh, afford alſo ſome very good ſpecimens of an irregular vein, which ſtill remains untraced; apparently the ſame ore is found on an eſtate belonging to the family of Dundonald, called La Mancha, 10 miles ſouth of Edinburgh; the lands of Cranſton alſo afford a ſimilar ore: the quality of the ore, in both of theſe places, may be reckoned upon the average to yield 42 per cent. of iron.

I have ſeen ſome very fine ſpecimens of iron-ore picked up in different parts of Fifeſhire, where no vein could poſſibly be diſcovered.

The fineſt Scotch ore I have ſeen, and which poſſeſſes mixtures congenial to the exiſtence of carbon in the blaſt furnace, is found in the Ochil-hills, not above two miles from the Devon iron-works. This ore is ſoft, looſely ſtriated, of a reddiſh colour, not very ponderous, but poſſeſſing a ſuperior quantity of iron.

The iron ore of the iſland of Iſlay is found regularly ſtratified, and reſembles, in point of depoſition, the Norwegian and Daniſh ores. The ſtrata are almoſt vertical, and are found imbedded in a looſe ochreous earth ſurrounded with ſoil: the fracture of this ore partakes of the nature of the imbedding earth; it abounds with ſhining ſpecula reſembling ſilex, but which, upon cloſer examination, prove to be plates of ſlightly magnetic iron-ore.

Having thus ſhortly enumerated ſome of various indications of the exiſtence of iron-ore in Britain, I ſhall ſubjoin the treatment of two of them widely different in their foſſile depoſition, their appearance, and their component parts; theſe

theſe ſhall be, the ore of the iſland of Iſlay, and the Cumberland iron-ore.

Of the former I pulveriſed 872 grs. which I threw into an iron veſſel of a red heat. In 15 minutes, during which time no ſenſible ſmell was diſengaged, the powder aſſumed a complete change of colour, and loſt in weight 12 grs. The ore was again returned into the furnace, and expoſed to a bright red heat for 5 minutes, in which time it loſt farther 28 grs. —in all 40 grs. = 4·58 per cent.

I next reduced to ſmall pieces 2700 grs. of this ore, and ſubjected them to a high heat for 8 hours, partially expoſed to air, in which time 314 grs. of volatile mixtures were driven off, equal to 11·2 per cent.

The ore had now aſſumed a reddiſh blue colour; had become friable, and much divided; it parted in ſmall granulated maſſes, like the fragments of quartz, but was conſiderably magnetic. The fracture was rough, full of aſperities; it did not effervеſce with acids, nor had it acquired any ſenſible increaſe of weight; when pulveriſed, the ſhining ſpecula were moſt conſpicuous, and very magnetic. Some of their ſurfaces, by avoiding the one pole of the magnet, and embracing the other, led me to ſuppoſe they had polarity. In order to de-oxygenate this ore, I introduced 2040 grs. in ſmall pieces, mixed with charcoal, into an iron teſt luted with clay, and expoſed the mixture to a high red heat for ten hours: the ore then ſeparated from the charcoal, and weighed, was found to have loſt, of volatile mixtures and oxygen, 456 grs. = 22·3 per cent.; from which deducting 11·2 as the quantity of volatile mixtures, being the quantity loſt by ſimple torrefaction as ſtated above, there remains 11·1 per cent. for oxygen taken up by the charcoal.

In this ſtate the ore had aſſumed a blueiſh colour; had become bulky and pulverulent, without exhibiting the ſmalleſt ſign of malleability: it was, however, ſo completely de-oxygenated, and the metal ſo much revived, as to deflagrate with the rapidity of iron filings.

I next

I next expoſed of this ore in ſmall pieces to a ſimilar temperature, in an open veſſel, - - 1804·2 grs.
After eight hours the fragments weighed - 2260

Gained in weight, by the combination of oxygen, 455·8 grs. equal to 25·2 per cent. of de-oxygenated ore, and to 19·6 of raw ore.

The magnetic virtue ſo eminently manifeſted in this ore was now totally loſt, and the individual pieces had acquired a ſenſible increaſe of weight. From this ore I obtained, by fuſion, a button of oxygenated crude iron, equal to - - - - 56·5
Oxygen taken up, as above - 11·1
Water of cryſtalliſation - - 11·2
Earths, chiefly ſilex and clay, - 12·2

100 parts.

The ſpecific gravity of this ſpecimen I found to be—in a raw ſtate, 3·370; de-oxygenated, 3·060; oxydated and combined with 25·2 per cent. oxygen, 4·000.

Of the many experiments I have made upon the Cumberland iron-ore, the following, at the preſent time, may ſerve as a comparative treatment with others. Of this ore, pulveriſed, I threw into a red hot veſſel - 218·5 grs.
Inſtantly a blue flame aroſe, and hovered nearly half a minute upon the ſurface of the powder: the ſmell was ſulphureous, penetrating, and ſtrong: the powder, after 5 minutes, was taken out, and weighed - - 212·5

Loſt of water and ſulphuric acid - - 6 grs.
The colour was conſiderably deepened, and the maſs had acquired a minute portion of magnetic obedience.

I next torrefied, of this ore, in an open teſt, - 2086 grs.
After a bright heat of eight hours, the reſidue weighed - - - 1961

Total loſs of water and ſulphur - 125 grs.

In order to de-oxygenate this ore, I introduced, mixed with charcoal, into an open veſſel, - 2894 grs.
This mixture was expoſed, under a high heat, for ten hours: when the ore was ſeparated from the charcoal, it weighed - - 2069

Total loſs of volatile mixtures = 28·5 per cent. 825 grs.

In this ſhort time the whole maſs had become malleable, highly poliſhed, and was finely converted: when heated, the pieces welded together, and were eaſily drawn into ſmall rods of good malleable iron.

In another experiment I expoſed, of the de-oxygenated ore, to a ſtill higher degree of heat than the former, 1841·5 grs.
The maſs, when cool, weighed - 2489

Gained in weight, by the combination of oxygen, 647·5 grs. equal to 35·16 of de-oxygenated ore, or 25·14 of raw ore.

The practical analyſis of this ſpecies of the Cumberland ore (a mixture of kidney and hæmatites) may be thus ſtated:

Carbonated crude iron obtained in the aſſay furnace - - - -	64·5
Water and ſulphur - -	6
Oxygen taken up - -	22·5
Earths, chiefly ſilex, - -	7
	100 parts.

The ſpecific gravities of the various ſtates of this ſpecimen I found to be—in a raw ſtate, 4·6623; de-oxygenated, and malleable, 6·3000; combined with oxygen, 5·1900.

IV. *Deſcrip-*

IV. *Deſcription of the Láchſha, or Lac Inſect* *. *By Mr.* W. Roxburgh, *Surgeon on the Madras Eſtabliſhment. Communicated by Dr.* James Anderson. *From the* Aſiatic Reſearches.

Some pieces of very freſh-looking Lac, adhering to ſmall branches of Mimoſa cinerea, were brought me from the mountains on the 20th of laſt month. I kept them carefully, and to-day, the 4th of December, fourteen days from the time they came from the hills, myriads of exceedingly minute animals were obſerved creeping about the lac, and branches it adhered to, and more ſtill iſſuing from ſmall holes over the ſurface of the cells: other ſmall and perforated excreſcences were obſerved with a glaſs amongſt the perforations, from which the minute inſects iſſued, regularly two to each hole, and crowned with ſome very fine white hairs. When the hairs were rubbed off, two white ſpots appeared. The animals, when ſingle, ran about pretty briſkly, but in general they were ſo numerous as to be crowded over one another. The body is oblong, tapering moſt towards the tail, below plain, above convex, with a double, or flat margin: laterally on the back part of the thorax are two ſmall tubercles, which may be the eyes: the body behind the thorax is croſſed with twelve rings: legs ſix; feelers (antennæ) half the length of the body, jointed, hairy, each ending in two hairs as long as the antennæ: rump, a white point between two terminal hairs, which are as long as the body of the animal. The mouth I could not ſee. On opening the cells, the ſubſtance that they were formed of cannot be better deſcribed, with reſpect to appearance, than by ſaying it is like the tranſparent amber that beads are made of: the external covering of the cells may be about half a line thick, is remarkably ſtrong, and able to reſiſt injuries

* This diſcovery of Mr. Roxburgh will bring Lac a genus into the claſs Hemiptera of Linnæus.

the

the partitions are much thinner: the cells are in general irregular ſquares, pentagons and hexagons, about an eighth of an inch in diameter, and one quarter deep: they have no communication with each other. All thoſe I opened during the time the animals were iſſuing, contained in one half, a ſmall bag filled with a thick red jelly-like liquor, replete with what I take to be eggs: theſe bags, or utriculi, adhere to the bottom of the cells, and have each two necks, which paſs through perforations in the external coat of the cells, forming the fore-mentioned excreſcences, and ending in ſome very fine hairs. The other half of the cells have a diſtinct opening, and contain a white ſubſtance, like ſome few filaments of cotton rolled together, and numbers of the inſects themſelves ready to make their exit. Several of the ſame inſects I obſerved to have drawn up their legs, and to lie flat: they did not move on being touched, nor did they ſhow any ſigns of life with the greateſt irritation.

December 5. The ſame minute hexapedes continue iſſuing from their cells in numbers: they are more lively, of a deepened red colour, and fewer of the motionleſs ſort. To-day I ſaw the mouth: it is a flattened point about the middle of the breaſt, which the little animal projects on being compreſſed.

December 6. The male inſects I have found to-day: a few of them are conſtantly running among the females moſt actively: as yet they are ſcarce more, I imagine, than one to 5000 females, but twice their ſize. The head is obtuſe; eyes black, very large; antennæ clavated, feathered, about $\frac{2}{3}$ the length of the body: below the middle an articulation, ſuch as thoſe in the legs: colour between the eyes a beautiful ſhining green: neck very ſhort: body oval, brown: abdomen oblong, the length of body and head: legs ſix: wings membranaceous, four, longer than the body, fixed to the ſides of the thorax, narrow at their inſertions, growing broader for $\frac{2}{3}$ of their length, then rounded; the anterior pair is twice the ſize of the poſterior: a ſtrong fibre runs

along

along their anterior margins: they lie flat, like the wings of a common fly when it walks or reſts: no hairs from the rump: it ſprings moſt actively to a conſiderable diſtance, on being touched: mouth in the under part of the head: maxillæ tranſverſe. To-day the female inſects continue iſſuing in great numbers, and move about as on the 4th.

December 7. The ſmall red inſects ſtill more numerous, and move about as before: winged inſects, ſtill very few, continue active. There have been freſh leaves and bits of the branches of both *Mimoſa Cinerea* and *Corinda* put into the wide mouthed bottle with them: they walk over them indifferently, without ſhowing any preference, or inclination to work or copulate. I opened a cell whence I thought the winged flies had come, and found ſeveral, eight or ten, more in it, ſtruggling to ſhake off their incumbrances: they were in one of thoſe utriculi mentioned on the 4th, which ends in two mouths, ſhut up with fine white hairs, but one of them was open for the exit of the flies; the other would no doubt have opened in due time: this utriculus I found now perfectly dry, and divided into cells by exceeding thin partitions. I imagine, before any of the flies made their eſcape, it might have contained about twenty. In theſe minute cells with the living flies, or whence they had made their eſcape, were ſmall dry dark-coloured compreſſed grains, which may be the dried excrements of the flies*.

* The Hindoos have ſix names for Lac; but they generally call it Lácſhà from the multitude of ſmall inſects, who, as they believe, diſcharge it from their ſtomachs, and at length deſtroy the tree on which they form their colonies: a fine Pippala near Criſhnanagar is now almoſt wholly deſtroyed by them.—NOTE BY THE PRESIDENT.

V. *Mayow anticipated: or, The Diſcoveries of* HOOKE *relative to the Compoſition of our Atmoſphere. Communicated by* Dr. THORNTON, *Phyſician to the General Diſpenſary.*

HOOKE's Micrographia was, by the Council of the Royal Society, ordered to be printed, November 23, 1664.—Speaking of charcoal, Hooke obſerves, that "the body to be charred or coaled may be put into a crucible, pot, or any other veſſel that will endure to be made red-hot in the fire without breaking, and then covered over with ſand, ſo as no part of it be ſuffered to be open to the air; then ſet into a good fire, and there kept till the ſand has continued red hot for a quarter, half, an hour or two, or more, according to the nature and bigneſs of the body to be coaled or charred; then taking it out of the fire, and letting it ſtand till it be quite cold, the body may be taken out of the ſand well charred and cleanſed of its wateriſh parts; but in the taking of it out, care muſt be had that the ſand be very near cold, for elſe, when it comes into the free air, it will take fire, and readily burn away.

"This may be done alſo in any cloſe veſſel of glaſs, as a retort, or the like; and the ſeveral fluid ſubſtances that come over may be received in a fit recipient, which will yet further countenance this hypotheſis: and their manner of charring wood in great quantity comes much to the ſame thing, namely, an application of a great heat to the body, and preſerving it from the free acceſs of the devouring air. This may be eaſily learned from the Hiſtory of Charring of Coal, moſt excellently deſcribed and publiſhed by that moſt accompliſhed gentleman, Mr. John Evelyn, in the 100, 101, 103 pages of his Sylva; to which I ſhall therefore refer the curious reader that deſires a full information of it.

"Next, we may learn what part of the wood it is that is the combuſtible matter; for, ſince we ſhall find that none, or very

very little of thoſe fluid ſubſtances that are driven over into the receiver are combuſtible, and that moſt of that which is left behind is ſo, it follows, that the ſolid interſtitia of the wood are the combuſtible matter. Further, the reaſon why uncharred wood burns with a greater flame than that which is charred, is as evident, becauſe thoſe wateriſh or volatile parts iſſuing out of the fired wood, every way, not only ſhatter and open the body, the better for the fire to enter, but, iſſuing out in vapours or wind, they become like ſo many little æolipiles, or bellows, whereby they blow and agitate the fired part, and conduce to the more ſpeedy and violent conſumption or diſſolution of the body.

" Thirdly, from the experiment of charring of coals (whereby we ſee that notwithſtanding the great heat, and the duration of it, the ſolid parts of the wood remain, whilſt they are preſerved from the free acceſs of the air undiſſipated) we may learn, that which has not, that I know of, been publiſhed or hinted, nay, not ſo much as thought of, by any; and that in ſhort is this.

" Firſt, that the air in which we live, move, and breathe, and which encompaſſes very many, and cheriſhes moſt bodies it encompaſſes, that this air is the menſtruum, or univerſal diſſolvent of all ſulphureous * bodies.

" Secondly, that this action it performs not till the body be firſt ſufficiently heated, as we find requiſite alſo to the diſſolution of many other bodies by ſeveral other menſtruums.

" Thirdly, that this action of diſſolution produces or generates a very great heat, and that which we call fire; and this is common alſo to many diſſolutions of other bodies made by menſtruums, of which I could give multitudes of inſtances.

" Fourthly, that this action is performed with ſo great a violence, and does ſo minutely act and rapidly agitate the ſmalleſt parts of the combuſtible matter, that it produces in

* A term which, at the time in which the author wrote, meant *any inflammable body.*

the diaphanous medium of the air, the action or pulſe of light, which, what it is, I have elſewhere already ſhewn.

" Fifthly, that the diſſolution of ſulphureous bodies is made by a ſubſtance inherent, and mixt with the air, that is like, if not the very ſame with that which is fixt in ſaltpeter, which by multitudes of experiments that may be made with ſaltpeter, will, I think, moſt evidently be demonſtrated.

" Sixthly, that in this diſſolution of bodies by the air, a certain part is united and mixt, or diſſolved and turned into the air, and made to fly up and down with it in the ſame manner as a metalline, or other body diſſolved into any menſtruums, does follow the motions and progreſſes of that menſtruum till it be precipitated.

" Seventhly, that as there is one part that is diſſoluble by the air, ſo are there other parts with which the parts of the air mixing and uniting do make a coagulum, or precipitation, as one may call it, which cauſes it to be ſeparated from the air; but this precipitate is ſo light, and in ſo ſmall and rarified or porous cluſters, that it is very volatile, and is eaſily carryed up by the motion of the air, though afterwards, when the heat and agitation that kept it rarified ceaſes, it eaſily condenſes, and commixt with other indiſſoluble parts, it ſticks and adheres to the next bodies it meets withall; and this is a certain ſalt that may be extracted out of ſoot.

" Eighthly, that many indiſſoluble parts being very apt and prompt to be rarified, and ſo, whilſt they continue in that heat and agitation, are lighter than the ambient air, are thereby thruſt and carryed upwards with great violence, and by that means carry along with them, not only that ſaline concrete I mentioned before, but many terreſtrial, or indiſſoluble and irrarifiable parts, nay, many parts alſo which are diſſoluble, but are not ſuffered to ſtay long enough in a ſufficient heat to make them prompt and apt for that action. And therefore we find in ſoot, not only a part that, being continued longer in a competent heat, will be diſſolved by the

the air, or take fire and burn; but a part alſo which is fixt, terreſtrial and irrarifiable.

"Ninthly, that as there are theſe ſeveral parts that will rarifie and fly, or be driven up by the heat, ſo are there many others, that as they are indiſſoluble by the aërial menſtruum, ſo are they of ſuch ſluggiſh and groſs parts, that they are not eaſily rarified by heat, and therefore cannot be raiſed by it; the volatility or fixtneſs of a body ſeeming to conſiſt only in this, that the one is of a texture, or has component parts that will be eaſily rarified into the form of air; and the other, that it has ſuch as will not, without much ado, be brought to ſuch a conſtitution; and this is that part which remains behind in a white body called aſhes, which contains a ſubſtance, or ſalt, which chymiſts call alkali: what the particular natures of each of theſe bodies are, I ſhall not here examine, intending it in another place; but ſhall rather add, that this hypotheſis does ſo exactly agree with all phænomena of fire, and ſo genuinely explicate each particular circumſtance that I have hitherto obſerved, that it is more than probable, that this cauſe which I have aſſigned is the true, adequate, real, and only cauſe of thoſe phænomena; and therefore I ſhall proceed a little further, to ſhew the nature and uſe of the air.

"Tenthly, therefore the diſſolving parts of the air are but few, that is, it ſeems of the nature of thoſe ſaline menſtruums or ſpirits that have very much flegme mixt with the ſpirits, and therefore a ſmall parcel of it is quickly glutted, and will diſſolve no more; and therefore, unleſs ſome freſh part of this menſtruum be applied to the body to be diſſolved, the action ceaſes, and the body leaves to be diſſolved and to ſhine, which is the indication of it, though placed or kept in the greateſt heat; whereas ſaltpeter is a menſtruum, when melted and red-hot, that abounds more with thoſe diſſolvent particles, and therefore, as a ſmall quantity of it will diſſolve a great ſulphureous body, ſo will the diſſolution be very quick and violent.

" Therefore, in the eleventh place, it is obſervable, that, as in other ſolutions, if a copious and quick ſupply of freſh menſtruum, though but weak, be poured on or applied to the diſſoluble body, it quickly conſumes it: ſo this menſtruum of the air, if by bellows, or any other ſuch contrivance, it be copiouſly applied to the ſhining body, is found to diſſolve it as ſoon and as violently as the more ſtrong menſtruum of melted nitre.

" Therefore, twelfthly, it ſeems reaſonable to think that there is no ſuch thing as an element of fire that ſhould attract or draw up the flame, or towards which the flame ſhould endeavour to aſcend out of a deſire or appetite of uniting with that as its homogeneal primitive and generating element; but that that ſhining tranſient body which we call flame, is nothing elſe but a mixture of air and volatile ſulphureous parts of diſſoluble or combuſtible bodies, which are acting upon each other whilſt they aſcend, that is, flame ſeems to be a mixture of air and the combuſtible volatile parts of any body, which parts the encompaſſing air does diſſolve or work upon, which action, as it does intend the heat of the aërial parts of the diſſolvent, ſo does it thereby further rarifie thoſe parts that are acting, or that are very near them, whereby they growing much lighter than the heavie parts of that menſtruum that are more remote, are thereby protruded and driven upward; and this may be eaſily obſerved alſo in diſſolutions made by any other menſtruum, eſpecially ſuch as either create heat or bubbles. Now, this action of the menſtruum or air on the diſſoluble parts, is made with ſuch violence, or is ſuch, that it imparts ſuch a motion or pulſe to the diaphanous parts of the air, as I have elſewhere ſhewn is requiſite to produce light.

" This hypotheſis I have endeavoured to raiſe from an infinity of obſervations and experiments, the proceſs of which would be much too long to be here inſerted, and will perhaps another time afford matter copious enough for a much larger diſcourſe, the air being a ſubject which (though all the

the world has hitherto lived and breathed in, and been unconverſant about) has yet been ſo little truly examined or explained, that a diligent enquirer will be able to find but very little information from what has been (till of late) written of it: but being once well underſtood, it will, I doubt not, enable a man to render an intelligible, nay probable, if not the true reaſon of all the phænomena of fire, which, as it has been found by writers and philoſophers of all ages a matter of no ſmall difficulty, as may be ſufficiently underſtood by their ſtrange hypotheſes and unintelligible ſolutions of ſome few phænomena of it; ſo will it prove a matter of no ſmall concern and uſe in human affairs, as I ſhall elſewhere endeavour to manifeſt when I come to ſhew the uſe of the air in reſpiration, and for the preſervation of the life, nay, for the conſervation and reſtauration of the health and natural conſtitution of mankind as well as all other aërial animals, as alſo the uſes of this principle or propriety of the air in chymical, mechanical, and other operations. In this place I have only time to hint an hypotheſis, which, if God permit me life and opportunity, I may elſewhere proſecute, improve and publiſh."

This appears to be exactly the doctrine of Mayow, who firſt publiſhed his treatiſe on reſpiration in 1668, and his other treatiſes on the compoſition of nitre, &c. in 1674, ſhewing clearly the priority of Hooke.

VI. *On a New Kind of Sympathetic Ink. By* M. Meyer. *From* Crell's Chemical Annals, *Vol. I.* 1798.

A TRAVELLER, who wiſhed to have ſympathetic ink of a roſe red colour, ſhewed me a receipt he had procured for preparing an ink of that kind; according to which, cobalt was to be diſſolved in the nitrous acid, and a quantity of ſaltpetre, equal to that of the cobalt diſſolved, was to be added to the ſolution; but as this proceſs had never ſuc-

ceeded with him, I reſolved to make ſome experiments to aſcertain the point. My firſt object was to procure pure cobalt; but as I was unwilling to ſacrifice pure pieces of any conſiderable ſize, I made choice of one which was viſibly mixed with biſmuth, iron and quartz. I endeavoured to ſeparate the biſmuth as much as poſſible, and alſo the arſenic if it ſhould contain any, by bringing it ſlowly to a red heat; and I ſucceeded pretty well, as the biſmuth flowed from it in abundance; and the arſenic, the quantity of which was ſmall, was volatiliſed: many globules of biſmuth ſtill adhered to it. By bringing it repeatedly to a red heat, and then quenching it in water, it was reduced to ſuch a ſtate as to be eaſily pulveriſed. Having poured nitrous acid upon the powder, I obtained by digeſtion a beautiful roſe red ſolution; the ſiliceous earth was ſeparated in the form of a white ſlime, and by diluting it with water there was depoſited a white powder, which was oxyd of biſmuth. The ſolution being filtered, I added to it a ſolution of potaſh, and obtained a precipitate inclining more to a yellow than to a red colour. I again poured over it a little of the nitrous acid, by which a part of the oxyd was re-diſſolved of a red colour: the remaining part, which had a dark brown colour, was oxyd of iron. From the ſolution, by the addition of potaſh, a precipitate was formed, which was now reddiſh. Having by this proceſs obtained it pure; that I might now prepare from it the wiſhed for red ink, I diſſolved the waſhen pure oxyd of cobalt in different acids. That diſſolved in the nitrous acid with a mixture of nitre, gave a green ink like the common: that diſſolved in the ſulphurous acid, without the addition of ſalts, gave a reddiſh ink, which remained after it was expoſed to heat, and would not again diſappear, even when a ſolution of nitre was applied; and that diſſolved in the muriatic acid gave a green ink, darker and more beautiful than the common. By diſſolving it, however, in the acetous acid, and adding a little nitre, I obtained what I had in view; for it gave, on the application of heat,

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an ink of a red colour, like that of the *roſa centifolia*, which again diſappeared when the paper became cold. I was not able to obtain it of a darker tint; but I muſt confeſs that I made only a few experiments for that purpoſe, as I was ſatisfied with the colour I had got.

VII. *Deſcription of* M. DE SAUSSURE'S *Diaphanometer. By Dr.* F. W. AUG. MURHARD, *of Gottingen. From* Neues Journal der Phyſik, *by Profeſſor* GREN. *Vol. IV.*

THIS inſtrument, firſt deſcribed by M. de Sauſſure in the fourth volume of the Memoirs of the Royal Academy of Sciences at Turin, has ſome reſemblance to the *cyanometer* *, both in regard to its object and conſtruction. The principal difference is, that the latter ſhews the whole effect of the vapour and evaporation diffuſed throughout the atmoſphere, from the eye of the obſerver to the utmoſt boundary of his view; while the diaphanometer is, on the other hand, deſigned to ſhew the greatneſs of the evaporations exiſting in any limited part of the atmoſphere which ſurrounds us.

The meaſure of tranſparency in M. de Sauſſure's inſtrument, is founded on the proportion of the diſtances at which determined objects ceaſe to be viſible; and the point was to find objects, the diſappearance of which, at a certain diſtance, could be determined with the greateſt accuracy. M. de Sauſſure found that the moment of diſappearance can be obſerved much more accurately when a black object is placed on a white ground, than when a white object is placed on a black ground; that the accuracy was ſtill greater when the obſervation was made in the ſun, than in the ſhade; and that even a ſtill greater degree of accuracy was obtained, when the white ſpace ſurrounding a black circle, was itſelf ſurrounded by a circle or ground of a dark colour. This laſt

* An inſtrument for determining the degree of the blueneſs of the heavens.

circumſtance

circumſtance was particularly remarkable, and an obſervation quite new.

If a circle totally black, of about two lines in diameter, be faſtened on the middle of a large ſheet of paper or paſteboard, and if this paper or paſteboard be placed in ſuch a manner as to be expoſed fully to the light or the ſun, if you then approach it at the diſtance of three or four feet, and afterwards gradually recede from it, keeping your eye conſtantly directed towards the black circle, it will appear always to decreaſe in ſize the farther you retire from it, and at the diſtance of 33 or 34 feet will have the appearance of a point. If you continue ſtill to recede, you will ſee it again enlarge itſelf; and it will ſeem to form a kind of cloud, the darkneſs of which decreaſes more and more according as the circumference becomes enlarged. The cloud will appear ſtill to increaſe in ſize, the farther you remove from it; but at length it will totally diſappear. The moment of the diſappearance, however, cannot be accurately aſcertained; and the more experiments were repeated, the more were the reſults different. This is an obſervation perfectly accurate; and having myſelf made a ſeries of experiments under like circumſtances, I am the more convinced of the truth of it.

M. de Sauſſure, having reflected for a long time on the means of remedying this inconveniency, ſaw clearly, that, as long as this cloud took place, no accuracy could be obtained; and he diſcovered that it appeared in conſequence of the contraſt formed by the white parts which were at the greateſt diſtance from the black circle. He thence concluded, that if the ground was left white near this circle, and the parts of the paſteboard at the greateſt diſtance from it were covered with a dark colour, the cloud would no longer be viſible, or at leaſt almoſt totally diſappear.

This conjecture was confirmed by experiment. M. de Sauſſure left a white ſpace around the black circle equal in breadth to its diameter, by placing a circle of black paper a line in diameter on the middle of a white circle three lines

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in diameter, ſo that the black circle was only ſurrounded by a white ring a line in breadth. The whole was paſted upon a green ground. A green colour was choſen, becauſe it was dark enough to make the cloud diſappear, and the eaſieſt to be procured.

The black circle, ſurrounded in this manner with white on a green ground, diſappeared at a much leſs diſtance, than when it was on a white ground of a large ſize.

If a perfectly black circle, a line in diameter, be paſted on the middle of a white ground expoſed to the open light, I can obſerve it at the diſtance of from 44 to 45 feet; but if this circle be ſurrounded by a white ring a line in breadth, while the reſt of the ground is green, I loſe ſight of it at the diſtance of only $15\frac{1}{2}$ feet.

According to theſe principles M. de Sauſſure delineated ſeveral black circles, the diameters of which increaſed in a geometrical progreſſion, the exponent of which was $\frac{3}{2}$. His ſmalleſt circle was $\frac{1}{5}$ or 0·2 of a line in diameter; the ſecond, 0·3; the third, 0·45; and ſo on to the ſixteenth, which was 87·527, or about 7 inches $3\frac{1}{2}$ lines. Each of theſe circles was ſurrounded by a white ring, the breadth of which was equal to the diameter of the circle, and the whole was paſted on a green ground.

M. de Sauſſure, for his experiments, ſelected a ſtraight road or plain of about 12 or 1500 feet in circumference, which towards the North was bounded by trees or an aſcent. Thoſe who repeat them, however, muſt pay attention to the following remarks:—When a perſon retires backwards, keeping his eye conſtantly fixed on the paſteboard, the eye becomes fatigued, and ſoon ceaſes to perceive the circle; as ſoon therefore as it ceaſes to be diſtinguiſhable, you muſt ſuffer your eyes to reſt; not, however, by ſhutting them, for they would when again opened be dazzled by the light, but by turning them gradually to ſome leſs illuminated object in the horizon. When you have done this for about half a minute,

and

and again directed your eyes to the paſteboard, the circle will be again viſible, and you muſt continue to recede till it diſappear once more. You muſt then let your eyes reſt a ſecond time in order to look at the circle again, and continue in this manner till the circle becomes actually inviſible.

If you wiſh to find an accurate expreſſion for the want of tranſparency, you muſt employ a number of circles, the diameters of which increaſe according to a certain progreſſion, and a compariſon of the diſtances at which they diſappear will give the law according to which the tranſparency of the atmoſphere decreaſes at different diſtances. If you wiſh to compare the tranſparency of the atmoſphere on two days, or in two different places, two circles will be ſufficient for the experiment.

According to theſe principles, M. de Sauſſure cauſed to be prepared a piece of white linen cloth eight feet ſquare. In the middle of this ſquare he ſewed a perfect circle, two feet in diameter, of beautiful black wool; around this circle he left a white ring two feet in breadth, and the reſt of the ſquare was covered with pale green. In the like manner, and of the ſame materials, he prepared another ſquare; which was, however, equal to only $\frac{1}{12}$ of the ſize of the former, ſo that each ſide of it was 8 inches; the black circle in the middle was two inches in diameter, and the white ſpace around the circle was 2 inches alſo.

If two ſquares of this kind be ſuſpended vertically and parallel to each other, ſo that they may be both illuminated in an equal degree by the ſun; and if the atmoſphere, at the moment when the experiment is made, be perfectly tranſparent, the circle of the large ſquare, which is twelve times the ſize of the other, muſt be ſeen at twelve times the diſtance. In M. de Sauſſure's experiments the ſmall circle diſappeared at the diſtance of 314 feet, and the large one at the diſtance of 3588 feet, whereas it ſhould have diſappeared at the diſtance of 3768. The atmoſphere, therefore, was not perfectly tranſparent.

tranſparent. This aroſe from the thin vapours which at that time were floating in it.

It is of great importance to aſcertain the laws according to which the diſtinctneſs of the viſibility of an object decreaſes, either when the tranſparency of the medium through which the object is viewed is leſſened, or when the thickneſs of the ſtratum of the medium is increaſed. Lambert, in his Photometry, has given an account of many ingenious experiments which he made on the decreaſe of the quantity of light, by its propagation through a medium imperfectly tranſparent; but M. de Sauſſure is the firſt who has conſidered the decreaſe of the diſtinctneſs with which an object is ſeen through ſuch a medium at different diſtances.

VIII. *Hiſtory of Aſtronomy for the Year* 1798. *Read in the College de France, Nov.* 20. *By* JEROME LALANDE, *Inſpector and Dean of the College, and formerly Director of the Obſervatory.*

BEING permitted for the tenth time to entertain the public with the progreſs of a ſcience which has engaged my attention fifty years, I am happy in being able to announce things ſtill more intereſting than on the laſt occaſion; and, in the firſt place, the concluſion of that grand operation the meaſurement of the earth, or of $9\frac{2}{3}$ degrees of the meridian from Dunkirk to Barcelona.

About the middle of January, Delambre, impatient to begin his fatiguing labours, proceeded, notwithſtanding the cold and the rain, to prepare a baſe from Lieurſaint to Melun; to complete the wooden pyramids, which were ſeventy feet in height, and to meaſure the angles.

On the 24th of February he had already finiſhed ſeven ſtations for the angles at the baſe: three men had been employed for ſix weeks to cut down and remove from the high-

way

way six or seven hundred trees which interrupted the view of the signals.

On the 17th of April he set out to measure the base from Melun to Lieursaint; a laborious operation, to which so much attention was paid that, though assisted by seven persons, they measured only 180 toises a day.

On the 3d of June the measurement of the base of three leagues, 6075 toises, was finished at Lieursaint.

On the 30th of June C. Delambre set out to measure the base of Perpignan, which was terminated by the middle of September. At the same time C. Mechain finished his triangles between Rodez and Carcassone, after being exposed to illness, impediments, and delays of every kind. Being more unfortunate, and less robust than his colleague, his zeal served only to torment him the more.

On the 17th of November they at length arrived at Paris, after finishing their calculations, from which it appeared that the two bases perfectly agreed. Thus this immense enterprise of a new measurement of the earth, begun in the month of June 1792, by our two ablest astronomers, is at length terminated; and we shall soon have the results so much wanted, for the size and figure of the earth, and perhaps for its irregularities. These two astronomers mean also to determine again the latitude of Paris, which I had fixed at 48° 50′ 15″ three years ago, from two hundred observations, made with an astronomical circle, for which we are indebted to C. Borda, by diminishing the refraction of Bradly one second, and this is all the uncertainty that remains.

The grand labour of determining the position of the stars, begun in 1789, has been carried to 47,000; and there remains only 2000 to complete the tour of the heavens as far as the lower tropic. By taking two degrees beyond it, there will be 50,000. C. Lefrançais proposes to finish this labour next winter. Comets are at present the only part of astronomy in which little progress has been made; but it is now about

about to engage the attention of our aſtronomers. I was deſirous of preparing for them the only aſſiſtance which was wanting, by giving them the poſitions of the ſtars in every part of the heavens. They will never be able to obſerve comets without being obliged to have recourſe to our 50,000 ſtars, and without being certain of finding there every thing they could wiſh: I know this by the experience of ſeveral years.

But detractors will never be wanting to every great and important work; they will ſay it would be much better to have fewer ſtars; and to have their poſitions aſcertained with more accuracy. They are however miſtaken; it is the great number of ſtars that ſupplies the data requiſite for this labour: a greater preciſion is uſeleſs at preſent, and will be ſo for a long time. Comets are never obſerved nearer than 30 ſeconds, and yet they wiſh to have the poſitions of the ſtars to one ſecond; this is an evident abſurdity, and a manifeſt impoſſibility. We have then done every thing that was neceſſary and poſſible to be done; and I conſider myſelf happy in having terminated my career, by procuring for aſtronomy a monument which, on account of its magnitude, might have been thought impoſſible. To ſhew the utility of C. Lefrançais' labour, it will be ſufficient to ſay, that in a zone of three hours, having two degrees of breadth, there were thirty new ſtars of the fifth and ſixth, and between the ſixth and the ſeventh magnitudes, yet no more than three of them were known. On the 10th of December 1789, of one hundred ſtars, thirteen of which were of the ſixth magnitude, there was only one known: the other twelve are new to us. This is enough to prove how far we were from being acquainted with the ſtarry heavens, and from knowing how many ſtars were viſible to the naked eye. For that reaſon I was induced to employ myſelf in this labour as ſoon as I was able to procure a good inſtrument. M. Herſchel has alſo undertaken a review of the heavens with his twenty-feet teleſcope, but only for the purpoſe of finding nebulæ, or objects difficult to be ſeen.

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Our labour is more important, since it gives the exact position of all the stars which astronomers may have occasion to use. Herschel observes only things invisible, and astronomers have need of sensible objects that are always present to their view.

We may therefore say of C. Lefrançais, what Virgil said of Palinurus: *Sydera cuncta notat tacito labentia cœlo*; for he has really done what Palinurus never did. C. Lefrançais has already reduced 6000, and he promises 4000 for the present year, though each requires thirty-six operations. In the month of September I caused to be erected in the Military School a new meridian telescope by Lenoir, with a large object-glass by Caroché: it is better placed than the former; the supports have no connection with the roof, and the instrument is less subject to vary by the changes of temperament. With this instrument we shall continue to determine the right ascension of the principal stars of all our zones of fifty thousand.

The theory of physical astronomy has also had a remarkable epoch this year. C. Laplace, to whom we are indebted for an explanation of the acceleration of the moon, has found that the apogeum and node have likewise secular equations; and this noble discovery has been confirmed by a great number of observations. It would be useful to confirm it still farther, by the observations of the middle ages, of which there are a few. The manuscript of Ibn-Iunis, an Arabian of the tenth century, contains valuable observations: the original is at Leyden, and we have made fruitless efforts to obtain a copy of it. C. Cauffin, one of our professors of Arabic, offered to go to Leyden and copy the observations; but I have found a copy among the manuscripts of J. Delisle, my predecessor in the *College de France*, and I hope we shall soon have the results of these valuable observations.

On the 19th of March, the Institute proposed, as the subject of a prize, a comparison of 500 observations of the moon, with the tables to determine better the 22 equations which we employ at present for the moon's motion; and I already know

know a competitor who has made immense calculations on that subject. Our prize will serve to terminate and render public that important labour which, united to Laplace's theory, will bring the moon's tables, and the calculation of the longitude, to a new degree of precision. If errors of three myrametres (seven leagues) were formerly committed at sea through the fault of the tables, they will soon be reduced to two or three.

C. Messier, who continues to search for comets, discovered one on the 12th of April 1798, towards the Pleiades; it was small, and without any tail, but of considerable brilliancy: it could not be distinguished by the naked eye. It forms the twenty-first which C. Messier has discovered since 1758, and the forty-first he has observed. The number of the comets now known is 88, according to the catalogue in my astronomy. Dr. Burckhardt, an able astronomer of Gotha, who had been some months at Paris, lost no time to calculate the orbit of this comet, which he did in two days, a circumstance very extraordinary. I have published C. Messier's observations, which Dr. Burckhardt reduced and calculated by employing several positions of the new stars furnished by C. Lefrançais, my nephew. This comet was almost as remote from us as the sun, and its distance varied little for a month. It ceased to be visible after the 24th of May. I had traced out its course on pasteboard for my auditors, as I generally do, and any one could there see its distance and situation for each day. C. Bouvard, at the observatory, made also various observations, which we shall publish with those of C. Messier, until they appear more at large in the Memoirs of the National Institute, with a chart of its course, as C. Messier always gave in the Memoirs of the ci-devant Academy. Dr. Olbers at Bremen observed it also as soon as he was informed of it by the *Journal de Paris*.

But before this real comet, Paris resounded with the report of a pretended comet. On the 16th of January a new

comet was announced on the Pont-Neuf, and many people were frightened. It however turned out to be only Venus, which was seen during the open day over the Luxembourg, at a time when 20,000 persons assembled to see General Bonaparte had their eyes directed towards that quarter. With proper attention, Venus might be seen in the like manner every 19 months; but few people have time or opportunity to make such observations. On this occasion the terror was singular. A piece called the *Comet*, or the *End of the World*, was represented at the Vaudeville. Ruggieri exhibited an artificial comet at the Lyceum: it had a great resemblance to the beautiful comet of 1744, which I recollect to have seen, and which was the most astonishing of that century.

On the 6th of December 1798, in the evening, C. Bouvard discovered a small comet in the constellation of Hercules. This makes the 89th. It was observed till the 11th, when it disappeared in Aquarius. It moved at the rate of eighteen degrees per day. Though it appeared only five days, we have, therefore, sufficient data to calculate its orbit. It was seen at Bremen by Dr. Olbers.

On the 21st of November a comic opera, called the Astronomer, was represented at the theatre in the *Rue Feydeau*. It is founded on a circumstance similar to that of the *Total Eclipse*; the first idea of which seems to have been borrowed from *Les Memoires Turcs*. It exhibits an old simpleton deceived while he pretends to observe a comet.

On the 18th of January, C. Dangos, at Tarbes, saw a comet pass over the sun like a black spot. This new and singular observation may be useful when we become acquainted with a great number of comets; but we are totally ignorant of the course of the one which was seen that day on the sun's disk.

An important and celebrated voyage has given new hopes to astronomy and geography. On the 16th of March government expressed a desire of having select astronomers and instruments for a secret expedition. We soon learned that the

the famous General Bonaparte was to be at the head of it. I could recommend only citizens Nouet, Quenot, and Mechain the son. They gladly embarked in this noble enterprize, and set out on the 24th of April. On the 10th of May they sailed from Toulon, landed in Egypt on the 2d of July; and I have no doubt that this voyage will be useful to geography, and even astronomy. I have written to all the astronomers of Europe to request them to co-operate, by corresponding observations, with those which will be made by the astronomers of that expedition.

Young Bernier, of Montauban, was desirous of sharing in the voyage, but we applied for him too late. I recommended to the attention of our astronomers, the level of the Mediterranean and the Red Sea, in which it has been often said there is a great difference, but I do not believe it. I have written to Spain to procure information in regard to that of the South Sea and the Gulph of Mexico, at the Isthmus of Panama, respecting which the like difficulties have been started.

The observatory of Gotha is the most beautiful and most useful in Germany. The duke has expended on it more than 200,000 livres. No prince or king in the present century has followed his example. M. von Zach, the director of the observatory, is one of the most celebrated astronomers in Europe. I had long wished to visit and be acquainted with the only monument of astronomy which I had not seen, after the example of Halley, who went from England to Denmark in 1679, to see the observatory of Hevelius, to converse with him, and examine the accuracy of his observations. I have found that M. von Zach can observe the polar star to a second, instead of a hundred seconds, which we had of uncertainty. Several German astronomers, being informed of this design, assembled there also. Our conferences served to increase our emulation. I brought back 1200 ascensions of zodiacal stars, each observed several times by M. von Zach, with the most beautiful transit instrument in existence. They

will appear, together with 3000 declinations which I have sent to M. von Zach, in an important work he is about to publish on astronomy, in two volumes octavo, and of which two thirds are already printed.

M. Bode brought from Berlin drawings of his thirteenth chart of the starry heavens. There will be twenty in the whole; and this collection, of the utmost value to astronomers, will contain 13,000 stars, or 8000 more than ever were represented before. He has reduced 3000 of Lacaille's stars, and has observed 1500 himself to fill up vacancies; C. Lefrançais supplied him with the rest. There will be found in it the 2000 nebulæ of Herschel, and from five to six hundred double stars of that celebrated astronomer. We have formed two new constellations, the Press of Guttemberg, and Mongolfier's Balloon.

M. Wurm came to meet us from Wirtemberg, the distance of a hundred leagues. The duke of Wirtemberg gave him a gratuity of 800 livres. He assured me that he would still collate the new stereotype tables of C. Firmin Didot, in order that this undertaking, which must ensure correctness to our calculations for more than a century, may be rendered as perfect and useful as possible.

Messrs. Klugel, Gilbert and Pistor, came from Halle, a celebrated university in the king of Prussia's dominions, and M. Schaubach from Meinungen. M. Seyffer, of Gottingen, promised us some observations and calculations, of which we are in want. M. Köhler brought with him a new pholometer to measure the light of the stars, and a reflecting selenostate, which is a very ingenious machine. M. Feer, of Zurich, brought a chart of the Rinthal, constructed from observations with a sextant. All these philosophers agreed to recommend the new system of measures, and to employ the mean time and decimal reckoning in their calculations. M. Seyffert, of Dresden, gave me a stop watch, with the hour plate divided according to the decimal method which was executed by himself. We went to the top of the

mountain

mountain of Inſelberg, with chronometers, ſextants, and artificial horizons of different forms, in order to compare them; and I am fully convinced that the geography of Germany will ſoon be improved by the uſe of theſe inſtruments, which M. von Zach has recommended and made better known.

This uſeful congreſs would perhaps have been more numerous; but M. Vega wrote to me from Auſtria, that he was not able to obtain permiſſion to meet us at Gotha; and, what is ſtill worſe, he was obliged to ſend my letter, and his own anſwer, to the miniſter for his inſpection. The king of Pruſſia, on the other hand, made an addition of 1200 livres to the allowance of his aſtronomer on account of this journey. The aſtronomer of Gottingen, though a ſubject of the king of England, experienced no difficulty.

An Engliſh Journal had hinted to the duke of Gotha, that a French aſtronomer might perhaps be employed with other revolutions than thoſe of the heavenly bodies; but I did not find that this ſuggeſtion diminiſhed in the leaſt the favourable reception I had been taught to expect. We at laſt ſeparated, after being fully convinced of the utility of ſuch conferences, and with a reſolution of renewing them as often as we could *.

[To be concluded in next Number.]

IX. *Obſervations and Experiments in regard to the Figures formed by Sand, &c. on Vibrating Surfaces, by* J. G. Voigt. *From* Neues Journal der Phyſik, *by Profeſſor* Gren, *Vol. III.*

Dr. CHLADNI of Wittemberg, by his experiments on vibrating ſurfaces, in the year 1787, opened a new field in mechanics, viz. the conſideration of the curves formed by ſurfaces put in a ſtate of movement. His diſcoveries, there-

* For Profeſſor Bode's account of this meeting of aſtronomers, ſee p. 324 of the preſent volume.

fore, were ſo much the more valuable; but, as far as I know, few beſides himſelf have employed their attention on this ſubject, and perhaps becauſe it requires long practice to perform experiments of this nature, ſo as to make progreſs in a branch of ſcience hitherto uncultivated. But, until theſe experiments ſhall more engage the attention of philoſophers, we cannot expect that the ſubject will be much illuſtrated; and therefore I conceive it may be of ſome utility if I here give a ſhort account of the method of making experiments on vibrating ſurfaces, which I hope will enable any one to repeat them with facility.

I have for ſome time paſt turned my attention to ſuch experiments, and I flatter myſelf that I have made improvements in regard to thoſe which Dr. Chladni announced in his *New Theory of Sound*. By my experiments I was conducted to many rules, a knowledge of which will render it very eaſy to repeat theſe experiments. I made them according to the inſtructions given by Dr. Chladni in the work above mentioned, which appears to me, however, to be rather too ſhort.

The vibration figures ariſe, it is well known, becauſe during the movement of a ſurface, which is connected with the ſenſation of ſound in our organs of hearing, ſome parts of the ſurface are at reſt, and others in motion. If the ſurface be ſtrewed over with bodies eaſily put in motion, ſuch for example as ſand, theſe during the vibration remain on the parts at reſt, and are thrown from the parts in motion. The form of the parts at reſt, which will be ſhewn by the ſand that remains unmoved, and which in general is ſymmetric, is called a vibration figure. To produce ſuch a figure, nothing is neceſſary but to know the method of bringing that part of the ſurface which you wiſh not to vibrate into a ſtate of reſt, and of putting in motion that which you wiſh to vibrate: on this depends the whole expertneſs of producing vibration figures.

The ſurfaces fitteſt for being made to vibrate, are panes

of

of glaſs, though the experiments will ſucceed equally well with plates of metal, or pieces of board, of a line or two in thickneſs. One might now believe that to produce fig. 2. (*See Plate* VIII.) it would be neceſſary to damp, in particular, every point of the part to be kept at reſt, viz. the two concentric circles and the diameter, and to put in motion every part intended to be made to vibrate. This, however, is not the caſe; for you need damp only the points *a* and *b*, and cauſe to vibrate one part *c* at the edge of the plate, for the movement is ſoon communicated to the other parts which you wiſh to vibrate, and the required figure will in this manner be produced. How and why the movement takes place in this manner, and in no other, is difficult to be explained, and would lead me too far, as I wiſh merely to give a few rules for making the experiments.

The damping may be beſt effected by laying hold of the place to be damped between two figures, or by ſupporting it only by one finger. This will be comprehended more clearly by turning to fig. 6. where the hand is repreſented in that poſition neceſſary to hold the plate. In order to produce fig. 3. you muſt hold the plate horizontally, placing the thumb above at *a*, with the ſecond finger directly below it; and, beſides this, you muſt ſupport the point *b* on the under ſide of the plate. If you then rub the bow of a violin againſt the plate at *c*, you will produce on the glaſs the figure which is delineated fig. 3. When the point to be ſupported or damped lies too near the centre of the plate, you may reſt it on a cork, not too broad at the end, in contact with the glaſs, in order to ſupply the place of the finger. It is convenient alſo, when you wiſh to damp ſeveral points at the circumference of the glaſs, to place your thumb on the cork, and uſe the reſt of your fingers for touching the parts which you wiſh to keep at reſt. For example, if you wiſh to produce fig. 4. on an elliptic plate, the larger axis of which is to the leſſer as 4 to 3, you muſt place the cork under the centre *c* of the plate; put your thumb upon this point, and then damp the two

points of the edge *p* and *q*, as may be ſeen fig. 5. and make the plate to vibrate by rubbing the violin bow againſt it at *r*. There is ſtill another convenient method of damping ſeveral points at the edge when you employ large plates. Fig. 1. repreſents a ſtrong ſquare bit of metal *a b*, a line in circumference, which is ſcrewed to the edge of a table, or made faſt in any other manner; and a notch about as broad as the edge of the plate is cut into one ſide of it with a file. You then hold the plate, reſting againſt this bit of metal by two or more fingers when requiſite, as at *c* and *d*; by which means the edge of the plate will be damped in three points *d*, *c*, *e*; and in this manner, by putting the plate in vibration at *f*, you can produce fig. 10. In caſes of neceſſity you may uſe the edge of a table inſtead of the bit of metal; but it does not anſwer the purpoſe ſo well.

To produce the vibration at any required place, a common violin bow rubbed with reſin is the moſt proper inſtrument to be employed. The hair muſt not be too ſlack, becauſe it is ſometimes neceſſary to preſs pretty hard on the plate, in order to produce the tone ſooner.

When you wiſh to produce any particular figure, you muſt firſt form it in idea upon the plate, in order that you may be able to determine where a line at reſt and where a vibrating part will occur. The greateſt reſt will always be where two or more lines at reſt interſect each other; and ſuch places muſt, in particular, be damped. For example, in fig. 7. you muſt damp the part *n*, and ſtroke with the bow in *p*. Fig. 11. may be produced with no leſs eaſe, if you hold the plate at *r*, and ſtroke with the bow at *f*. The ſtrongeſt vibration ſeems always to be in that part of the edge which is bounded by a curve: for example, in fig. 8. and fig. 9. at *n*. To produce theſe figures, therefore, you muſt rub with the bow at *n*, and not at *r*.

You muſt, however, damp not only thoſe points where two lines interſect each other, but endeavour to ſupport at leaſt one which is ſuited to that figure and to no other.

For

For example, when you ſupport *a* and *b* (*fig.* 2.), and rub with the bow in *c*, fig. 7. alſo may be produced, becauſe theſe figures have both theſe points at reſt. To produce fig. 2. you ſupport with one finger the part *e*, and rub with the bow in *c*; and in this manner fig. 7. cannot be produced, becauſe it has not the point *e* at reſt. One of the greateſt difficulties in producing the figures is to determine before hand the vibrating and reſting points which belong to a certain figure and to no other.

Hence it happens that when one is not able to ſupport thoſe points which diſtinguiſh one figure from another, if the violin bow be rubbed againſt the plate, ſeveral hollow tones are heard without the ſand forming itſelf as expected. One muſt therefore acquire by experience a readineſs in being able to ſearch out, among theſe tones, that which belongs to the required figure, and to produce it on the plate by rubbing the bow againſt it. But it requires great practice to determine the figure previouſly from the tone, or to ſearch out, among various tones, that which belongs to the figure, and to know how to make the plate vibrate in ſuch a manner that this tone alone, and not another, ſhall be heard. For this purpoſe you muſt firſt liſten, and then alter the mode of rubbing; and as ſoon as the right tone is produced, you muſt rub ſomewhat harder with the violin bow, by preſſing it more ſtrongly againſt the edge of the plate. The latter muſt be done in particular in regard to high tones. As ſoon as you have acquired ſufficient expertneſs in this reſpect, you can, as I myſelf have experienced, determine before hand, with a conſiderable degree of certainty, the figures to be produced, and even the moſt difficult. This practice will be attended with the greateſt advantage, if, when you rub the bow againſt the plate for the firſt time in order to produce a figure, you continue the rubbing that the tone may be imprinted in the memory, and if you try, after ſome time, to produce the ſame tone again. It may be readily conceived that you muſt not forget what parts of the plate, and in what manner you

damped;

damped; and you may mark theſe points by making a ſcratch on the plate with a bit of flint.

When the plate has acquired the proper vibration, you muſt endeavour to keep it in that ſtate for ſome ſeconds, which can be beſt done by rubbing the bow ſeveral times in ſucceſſion. By theſe means the ſand will be formed much more accurately.

Any ſort of glaſs may be employed for theſe experiments, provided its ſurface be ſmooth; otherwiſe the ſand will fall into the hollow parts, or be thrown about in an irregular manner. The ſurface of the common green glaſs is, however, not very ſmooth, and often full of cavities. The figures, therefore, formed upon it are not ſo clear and accurate as thoſe formed upon ſmooth white glaſs, which is the kind I employ.

When there are ſeveral places on the plate where there are ſtripes in the maſs of the glaſs, they hurt the experiments, eſpecially in producing thoſe figures where a vibrating part falls upon ſeveral of theſe ſtripes. In that caſe the figures are not ſo ſymmetric as on other plates. I have in my poſſeſſion, for example, a circular plate of glaſs 20 inches in diameter, on which I was never able to produce a perfect circle as on other plates, the circle always appearing like a very long ellipſe. This plate contains a great many of the above-mentioned ſtripes. The flaws and knots which occur in glaſs are not very hurtful.

Common glaſs plates, when cut with a ſtone, are very ſharp on the edge, and would ſoon deſtroy the hair of the violin bow: on this account the edge muſt be rendered ſomewhat ſmooth. For that purpoſe I employ a file or a piece of coarſe hard free ſtone. It is of no great conſequence, according to my obſervations, whether the edges be very ſmooth or roughly ground, provided they be in ſuch a ſtate as not to injure the hair of the bow.

You muſt endeavour to procure ſuch plates as are pretty equal in thickneſs. It may be ſaid, in general, that a plate

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the thinner it is will be ſo much the fitter for theſe experiments, though in this reſpect there is a certain minimum. In ſmall plates, ſuch as thoſe that are circular, and not above ſix inches in diameter, the obſervation is general; but in larger plates too great thinneſs is prejudicial. Beſides, it will be found that very thin glaſs is commonly very uneven, and, as has been already ſaid, muſt therefore be unfit for the experiments. If you have a plate, however, which is on one ſide thicker than on the other, you muſt endeavour to produce the figure on the plate in ſuch a manner that you can rub the violin bow againſt the thinneſt part.

In the laſt place, in practiſing the experiments, you muſt have glaſs plates of different ſizes, ſuch, for example, as circular ones of from four to twelve inches in diameter: for, on a ſmall one of four inches in diameter, you cannot produce three concentric circles with two or more diameters; and on a larger, for example, of twelve inches of diameter, you cannot ſo eaſily produce a ſingle circle as on a circular plate of three inches diameter. Sometimes it is difficult to make the figure appear on a plate, while on another it is very eaſy. Sometimes it appears only when you hold the plate in a certain place. Theſe are phenomena which ariſe partly from the unlike thickneſs of the glaſs, and partly from the ſtripes and flaws in it.

You muſt not employ too fine ſand, but rather that which is coarſer; becauſe the former is eaſier thrown from the vibrating parts, while the latter adheres better to them. It muſt be of ſuch a nature that when you incline the glaſs-plate it may readily roll off; becauſe, in that caſe, it will be eaſily thrown from the vibrating parts. It will be of advantage that it be mixed with fine duſt, which ſhews peculiar phenomena during the experiments, as it collects itſelf at one place of the vibrating part.

The plate muſt be equally beſtrewed with ſand, and not too thick, as the lines will then be exceedingly fine, and the figures will acquire a better defined appearance.

Thoſe

Thoſe who wiſh to exerciſe themſelves in theſe experiments may try to produce the figures ſpoken of by Dr. Chladni, in his before-mentioned work, following his directions, and the rules here given: but they muſt not be diſcouraged if the figures are not produced on the firſt trials; for, in general, to learn the method of making the experiments requires ſome time.

The above rules contain ſome general laws which vibrating ſurfaces follow; but as my object here was to give only a ſhort view of the manner in which experiments muſt be made, I ſhall not enter into a further explanation of theſe laws, as I mean to treat the ſubject more fully on ſome other occaſion.

X. *Communication from Mr.* CRUICKSHANK, *Chemiſt to the Ordnance, relative to a Miſtake in the laſt Edition of Dr.* SMYTH's Treatiſe on the Effects of Nitrous Vapour in preventing and deſtroying Contagion. *With an Account of the Methods now employed at Woolwich for fumigating with the Sulphurous Acid, and with Oxygenated Muriatic Acid Gas.*

TO THE EDITOR OF THE PHILOSOPHICAL MAGAZINE.

SIR,

IN the laſt edition of Dr. Smyth's Treatiſe on the effects of nitrous vapour in preventing and deſtroying contagion, I was not a little ſurpriſed to find, at page 221, the following paſſage, in a letter to Dr. Percival, dated Auguſt 1, 1796:

"Whether this will apply to the ſmall-pox, I cannot ſay "from my own experience; but I have been told by Dr. Rollo "ſurgeon to the artillery, and Mr. Cruickſhank profeſſor-royal "of chemiſtry to the academy, that it deſtroys the miaſma of "ſmall-pox; and that, of two quantities of matter taken for "the purpoſe of inoculation, one was expoſed to the nitrous "vapour, the other not: the perſons inoculated with the

" firſt were not ſeized with the diſeaſe, whilſt the inoculation " took the uſual effect when performed with the ſecond."

In the converſation which Dr. Rollo and myſelf had with Dr. Smyth, about the different methods of deſtroying contagion, I gave it as my opinion, that the ox. muriatic acid, in the form of gas, deſerved the preference, for the following reaſons:—1ſt, From its being a permanently elaſtic fluid, it was much more diffuſible than the vapour of nitrous acid—and, 2ndly, from the facility with which it deſtroyed the contagion of ſmall-pox in the moſt concentrated ſtate, I had little doubt of its efficacy in eradicating contagions in general. I then mentioned the experiments with ſmall-pox matter, which are related in the firſt edition of Dr. Rollo's Treatiſe on Diabetes *. How the Doctor could confound this gas with the vapour of nitrous acid, with which at that time I had made no trials, it is difficult to conceive; but however this may be, it is neceſſary the miſtake ſhould be corrected: for, although it be poſſible, and even probable, that nitrous vapour may deſtroy the contagion of ſmall-pox, yet it ſhould never be admitted as a fact until proper and ſatisfactory experiments have been made. In the ſame converſation I mentioned the method now employed at Woolwich for fumigating with the ſulphurous acid, and which we ſuppoſed had ſome advantages over that uſually practiſed. It conſiſts in mixing intimately two or three parts of pulveriſed ſulphur with one of nitre; a certain quantity of this mixture, proportioned to the ſize of the apartment, is to be introduced into an iron pot,

* Mr. Cruickſhank, in March 1795, took two portions of recent ſmall-pox matter from the ſame perſon, and expoſed one portion to this gas (the ox. mur. acid gas) for a few minutes, and with it inoculated the left arms of three drummers, while the right arms were inoculated with ſome of the other portion. The punctures of the left arms had no marks of inflammation, except what ſimple puncture produces, and they entirely diſappeared in a few days. But the right arms took on the variolous action, and in two of the perſons there was a general eruption. This experiment has been ſince repeated, and with the ſame ſucceſs. *Rollo on the Diabetes Mellitus*, vol. i. p. 61.

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and placed upon ſome bricks, or wet ſand, in the middle of the floor. After the people have been removed, and the windows, &c. cloſely ſhut, the compoſition is to be ſet on fire by a live coal. During the combuſtion a great quantity of ſulphurous acid gas, mixed with ſulphuric acid in the ſtate of vapour, is diſengaged, and concentrated to ſuch a degree as to force its way into the ſmalleſt apertures.

In the common method of burning ſulphur it is impoſſible to concentrate the ſulphurous acid in this manner, as the combuſtion ceaſes when the pure air in the room, &c. is nearly conſumed; but in this caſe the oxygene is ſupplied by the nitre, and, the combuſtion being carried on with great rapidity, a prodigious quantity of gas, &c. is diſengaged in a very ſhort ſpace of time.—It is true that this mode of fumigation cannot be put in practice while the patients are preſent: we doubt much, however, if the ſame objection is not applicable to any other, which ſhall be completely effectual in every caſe; for, to prevent the generation and ſpreading of contagion, is a very different thing from entirely eradicating it, after it has been produced, and attached to the clothing, furniture, &c.

The proceſs for diſengaging the oxygenated muriatic acid gas, in wards containing offenſive ſores and infectious diſeaſes, is alſo extremely ſimple:—Four ounces of common ſalt, intimately mixed with two ounces of pulveriſed manganeſe, are introduced into a cup or ſmall baſon; to this mixture about two ounces of water are firſt added, and afterwards three ounces of the concentrated ſulphuric acid in ſmall portions at a time, each portion being ſufficient to diſengage ſuch a quantity of gas as can be borne with eaſe by the patients in the room: when managed in this way, the ſmell of the gas is far from being offenſive, and its effects in removing putrid and diſagreeable ſmells much ſuperior to any other means we have ever tried. (See the note, p. 397.) We do not, however, by any means deny the efficacy of the nitrous vapour: our principal objection to it, ariſes only from its ready condenſation,

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and the difficulty of diffuſing it completely. But there is one circumſtance on which the Doctor appears to place ſome reliance, the truth of which we very much doubt, and that is, that, during the diſengagement of the vapour of the nitrous acid, a conſiderable quantity of pure air, or oxygene gas, is at the ſame time let looſe; an opinion which is likewiſe ſupported by Mr. Keir. Now, from the generally received theory reſpecting the difference between the white and orange-coloured vapour, (and it is the laſt which is almoſt uniformly generated in cloſe veſſels, or where pure air is excluded,) a quite oppoſite effect ſhould take place, that is, the production of the white vapour ſhould be accompanied by a diminution of the oxygene gas in the room or apartment. In order to ſatisfy myſelf with regard to this fact, I made ſeveral experiments, the reſults of which were, that, when a cup containing a mixture of heated nitre and concentrated ſulphuric acid was placed under a glaſs jar inverted over water, the air in the jar, after the nitrous vapour had been condenſed, was found to have the proportion of its oxygene ſomewhat diminiſhed, the difference being nearly as 93 to 90, or 31 to 30. This difference, which could not be perceptible in a large chamber, having only the uſual quantity of nitrous vapour diffuſed through it, is but ſmall, and I confeſs much leſs than was expected: it proves, however, that no oxygene gas is diſengaged. In theſe trials the jar, after ſome time, was filled with orange-coloured vapours; and this never failed to be the caſe, where the heat of the materials, and ſtrength of the ſulphuric acid, were ſufficient to diſengage any quantity of nitrous acid. In the diſtillation of this acid, it is true, that a little pure air is diſengaged towards the end; but this never happens until the bottom of the retort becomes red, and then the acid itſelf is decompoſed, which can never take place in Dr. Smyth's proceſs.

By giving a place to the preceding remarks in your valuable Magazine, you will greatly oblige

Yours, &c. &c.

Woolwich, May 12th, 1799. W. CRUICKSHANK.

XI. *Report made to the French National Inſtitute, by* C. GUYTON *and* DARCET, *in regard to the Reſults of the Experiments of* C. CLOUET, *on the different States of Iron, and the Converſion of it into Caſt Steel. From the* Journal des Mines, *No. XLV.*

THE memoir of C. Clouet is entitled Reſults of Experiments on the different States of Iron. He firſt treats of the combinations of iron and carbon. A thirty-ſecond part of carbon, ſays he, is ſufficient to convert iron into ſteel: a quantity of it equal to a ſixth part of the weight of the iron, gives a ſteel more fuſible and ſtill malleable; but beyond that term it approaches to caſt-iron, and has no longer ſufficient tenacity. By increaſing the doſe of carbon you increaſe the fuſibility, and it paſſes at length to the ſtate of grey caſt iron.

The particular kind of caſt iron reſulting from a combination of iron and glaſs, is the ſecond object which engages the attention of C. Clouet. Glaſs never enters into it but in a very ſmall quantity, yet its properties are changed. This iron, though exceedingly ſoft under the file, when brought only to a cherry-red heat, divides itſelf under the hammer; when poured into the ingot-mould, ſhrinks conſiderably; and when formed into plates, tempering gives them the grain of ſteel, and renders them more brittle, without giving them more hardneſs. Charcoal duſt added to glaſs changes the reſult, and increaſes the fuſibility; but the doſe has a ſenſible influence on the products. From a thirtieth to a twentieth in one part of iron gives a very hard tempered ſteel, which ſuffers itſelf to be forged at a cherry-red heat, and which has all the properties of caſt ſteel. By employing more carbon, you get only caſt iron.

The affinity of iron for carbon is ſo great, that at a high degree of temperature it even takes it from carbonic acid. This he proves by the following experiment:—If you put into a crucible

a crucible iron cut into ſmall pieces, along with a mixture of equal parts of carbonat of lime and argil, expoſe them to the degree of heat neceſſary to weld iron, and maintain this heat for an hour or more, according to the ſize of the crucible; the metal when poured into the ingot-mould will be ſteel ſimilar to caſt ſteel.

The oxyds of iron are equally ſuſceptible of paſſing to a ſtate of ſoft iron, ſteel, and caſt iron, according to the proportions of carbon employed. The black oxyd of iron, the ſtate of which ſeems to be the moſt unalterable, becomes iron when treated in the crucible with an equal volume of charcoal powder: by doubling that quantity you will have ſteel, and a progreſſive augmentation gives it the characters of white and grey caſt iron. In a word, C. Clouet obſerved the ſame tranſitions, and always depending on the reſpective quantities in treating caſt iron and the oxyd of iron, caſt iron and forged iron, the oxyd of iron and iron, the oxyd of iron and ſteel. A fifth part only of caſt iron is neceſſary to render iron ſteel. The iron and the oxyd do not unite intimately; the black oxyd mixed with a half leſs of carbon than is neceſſary for its reduction, gives a ſoft iron, but not very tenacious, black and without a granulated fracture. A ſixth part of the oxyd brings back common ſteel to the ſtate of iron, by treating them together either in the forge or by cementation.

At the end of his memoir C. Clouet gives ſome obſervations on the method of producing caſt ſteel, and the furnaces proper for that purpoſe. He determines the proportions of the ſubſtances to be fuſed; the degree of heat; the precautions to be employed in pouring them into the ingot-mould; the method of forging this kind of ſteel; the proceſſes to be employed for aſſays, in a common forge, upon three or four pounds of matter; and the proportions to be given to a reverberating furnace to operate at the ſame time with four crucibles, containing each from twenty-three to twenty-ſix pounds of ſteel. He remarks, that ingredients of ſaline glaſs cannot

be employed with advantage; that glaſs, too fuſible, renders ſteel difficult to be forged; that ſteel kept a long time in fuſion, takes up more glaſs than it ought; and laſtly, that the metal muſt be ſtirred, and the glaſs taken carefully away before it is poured out, in order that it may not mix itſelf with the ſteel. After giving a ſhort view of the obſervations of C. Clouet, and the practical conſequences which he deduces from them, it would have remained for us only to lay before you ſome ſpecimens produced by his operations, had we not thought it our duty to add the reſults of the experiments which we made ourſelves, by following his proceſſes for the immediate converſion of iron into caſt ſteel, and of which it is of importance that we ſhould deſcribe the principal circumſtances.

The members of the Council of Mines having permitted us to make uſe of the forge conſtructed in their laboratory, we put into a luted Heſſian crucible 6 hectogrammes (1·23 lb.) of the points of horſe-ſhoe nails, and 4 (·81 lb.) of a mixture of equal parts of the carbonat of lime (white marble) and burnt clay, from a Heſſian crucible, all reduced to powder. The mixture was heaped up to ſurround the iron fragments on every ſide; and the crucible placed upon its ſtand in the middle of the furnace, the heat of which was urged by three blaſts. In our firſt trial we found, after about an hour and a half, that the matter was fuſed; but the crucible having burſt, we were prevented from pouring it out. On repeating the operation at the ſame forge, and in the ſame manner, we obtained an ingot; a portion of which we now ſubmit to the inſpection of the Claſs. It forms a ſquare bar, each face of which is from 26 to 27 millimetres (about one inch Engliſh).

The frequent and almoſt unavoidable accidents which crucibles experience by being expoſed to the blaſt of bellows, made us think it a point of importance to aſcertain whether the operation would ſucceed equally well in a reverberating furnace or any other wind furnace, as C. Clouet announces.

We

We firſt employed a Macquer's furnace in one of the laboratories of the Polytechnic School. Though its ſtate of derangement did not give us reaſon to hope for the whole effect of the principles of its conſtruction, a pyrometric piece placed in a ſeparate crucible indicated that the heat had been carried to 151 degrees. The crucible did not appear to be either broken or cracked; yet the fuſion was incomplete, and even a portion of the iron remained uncovered above the portion of the vitreous maſs, without it being poſſible to diſcover the cauſe.

We then reſolved to repeat the experiment at a founder's furnace; and C. Lecour, aſſayer of the mint, was ſo kind as to permit us to operate with that in his laboratory. Our ſucceſs exceeded what we expected, conſidering the ſize of the furnace. A particular deſcription of this operation appeared to us the beſt means of ſatisfying the demand of government, ſince it tends to eſtabliſh the poſſibility of a manufactory of this kind on a large ſcale, and to give from obſervation the baſis of this new art.

We repaired to the laboratory of C. Lecour in the mint, with our colleague Vauquelin, who aſſiſted us in our experiments. The wind furnace is conſtructed of brick. The fireplace *a* is a ſquare cavity of 25 centimetres (9·23 inches) on each internal face, 45 centimetres (16·62 inches) in height, terminated at the bottom by a grate *b* of ſeven ſquare bars 27 millimetres (one inch) in thickneſs, and raiſed 25 centimetres (9·23 inches) above the bottom of the aſh-hole. The mouth has an iron cover *c*, with hinges inclined about 25 degrees (ſee Plate IX.) from a perpendicular. The tunnel *dd*, by which the furnace is terminated, is built of bricks alſo. It commences above the aperture of the cover, and firſt forms a ſquare, each face of which internally is equal to 25 centimetres; but it becomes narrower as it aſcends, ſo that each face at the extremity is a fifth leſs. This tunnel riſes, inclined againſt the wall, to the height of 13 decimetres (about four feet.) It is there connected with a large chimney raiſed about 15

metres (or 45 feet), the exceſs in the width of which is cloſed by a trap *e* moving on hinges when the furnace is at work. We had previouſly put into a Heſſian crucible 15 centimetres (about $5\frac{1}{2}$ inches) in height, and 8 in diameter, 367 grammes (6914 grains) of ſmall iron nails, and 245 grammes (4616 grains) of a mixture of carbonat of lime and burnt clay. This crucible was placed on its ſtand in the middle of the furnace.

At one of the corners of the bottom was placed a ſmall crucible of kaolin with its cover, and containing two of Wedgewood's pyrometrical pieces, taken from two different boxes. We readily foreſaw that in this poſition they would not receive the ſame degree of heat as the crucible placed in the centre; but it was a mode of eſtimation not to be neglected. The fire was kindled about half an hour after ten, and urged at firſt very ſlowly. At one o'clock we judged the fuſion to be complete, took away the vitreous part, and poured the matter into the ingot-mould. A part of the matter remained fixed in the crucible, becauſe too much time was employed in removing the laſt portions of the glaſs, and becauſe perhaps a quarter of an hour more heat would have been neceſſary; but the moulded portion, by its form and grain, left no doubt of proper fuſion, and of its perfect converſion into ſteel. The pyrometric pieces, placed at the corner of the furnace, gave one 136 degrees, and the other 140; from which it may be inferred, that the matter in the large crucible was expoſed to a heat of about 150 degrees.

"Caſt ſteel," ſays Perret in his Memoir which obtained the prize from the Society of Arts at Geneva, "is judged by moſt ſmiths intractable; but it is ſtill poſſible to overcome it by attention and addreſs." That of C. Clouet requires the ſame precautions, which depend on its peculiar nature; and it affords a proof that it may be forged, and that in this ſtate, even though its grain be not rendered finer by tempering, it will bear a compariſon with the Engliſh caſt ſteel. We ſubjected alſo to trial, by forging, a ſmall piece

obtained

obtained by fuſion in a wind furnace: the grain of its fracture, after having been forged, fully confirmed the opinion which we formed of it when caſt.

The ingots almoſt always exhibit on their fracture ſmall cavities, which it might be ſuppoſed would produce faults in the forging; but as they are clear and free from all foreign matter, they form no obſtacle to the union of all the parts. Beſides, it will be eaſy to prevent this accident by a ſlower cooling in the ingot mould, which will naturally take place in operating upon larger maſſes. We ought not to omit that this ſteel, when forged into bars, is exactly in that ſtate which Rinman indicates as one of the characters of caſt ſteel. Its ſpecific gravity is to that of the fineſt ſteel, not caſt, in the proportion of 7·917 to 7·79.

However concluſive theſe reſults may be, it appears that ſomething would ſtill be wanting, if we did not at the ſame time produce a ſpecimen of what an able hand, accuſtomed to manage the Engliſh caſt ſteel, can do with ours in the fabrication of thoſe inſtruments to which Engliſh ſteel gives ſo much ſuperiority: we have the ſatisfaction of being able to exhibit this proof alſo of the utility of C. Clouet's diſcovery.

A bar of ſteel ariſing from the caſt made at the *Depôt des Machines du Conſervatoire*, was delivered by C. Molard to C. Lepetitwalle, proprietor of the national manufactory of ſteel razors at the *Quinze-vingts, faubourg Antoine*. He made of it three razors, viz. two without any preparation, and one after having taken away the *apperçus* (the name given to the ſmall fiſſures found at the ſurface and on the edges). This artiſt declares, that "the latter was manufactured with great facility, conſidering the quality of the metal; that it will bear compariſon with thoſe of the fine Engliſh ſteel named Marſchall and B. Huntzman; and that all the three are excellent for any beard whatever."

Hitherto we have confined ourſelves to an examination of

the proceſſes and productions which have more particularly attracted the attention of Government; but we cannot terminate this report without pointing out, in a few words, the truths of the theory ariſing from them. It is well known that iron does not become ſteel, but by aſſuming about 0·2013 of its weight of carbon: here it is furniſhed only in the ſtate of carbonic acid; this acid then is decompoſed. This is a very important phenomenon, which the obſervation of C. Clouet has added to the proofs of the doctrine of the French chemiſts. But how is this decompoſition effected?—It evidently reſults from the eventual or prediſpoſing affinity which a portion of the iron exerciſes upon the oxygen of the acid, at the ſame time that the remainder of the iron tends to unite itſelf with the carbon; and a concurrence of theſe attractions produces a reſult which one would not have expected, and which would not indeed have been poſſible by ſimple affinity. Thus in this operation the vitreous flux is always ſeen charged with the oxyd of iron, the preſence of which diſcovers itſelf by a very dark green colour. The experiment in which the iron was not fuſed, has enabled us to exhibit to you a proof of it. Hence it might perhaps be inferred, that this indiſpenſible oxydation of a portion of the iron occaſions in the product a decreaſe of ſo much the more importance, as iron only of the beſt quality can be employed in the operation. This conſideration made us pay attention to the decreaſe, in order that we might at leaſt give ſome idea of its probable limits. In the operation conducted at the wind furnace, the decreaſe was not altogether a twelfth; in another experiment made at the forge of the School of Mines, before C. Vauquelin, in 428 grammes of iron there was a loſs only of 19 grammes, that is to ſay, leſs than a twenty-ſecond part. We may then reſt aſſured that this loſs will be compenſated by the value which the reſt of the matter will acquire; and that, inſtead of increaſing, it muſt be diminiſhed when working on a large ſcale, for it is

evident

evident that it is produced chiefly by an accidental ſcorification, and always more in proportion to the ſurface than to the maſs.

It now remains that we ſhould ſtill make, in regard to the proceſs itſelf, a remark which ſeems proper to ſhew the ſuperiority of it to all thoſe hitherto uſed for the converſion of iron into ſteel. It is well known that the great difficulty is to make it take up the proper doſe of carbon; below that you have ſoft ſteel; and above it, ſteel ſuperſaturated almoſt to the ſtate of caſt iron, and as refractory. Ought not the quantity to be determined here by the concurrence of the forces of the affinity which operate the decompoſition of the carbonic acid? The degree of ſaturation would be then conſtant, and the product always uniform; and it may be readily comprehended how much value this condition, which we mention only as probable, would add to the new method.

From theſe reflections, and the facts mentioned in this report, we conclude, that the obſervations of C. Clouet on the different ſtates of iron diffuſe a new light over the manner of treating this metal; that the immediate converſion of ſoft iron into caſt ſteel, without employing carbon, and by the decompoſition of the carbonic acid, is a diſcovery as important for the advancement of the theory of chemical affinities, as it is valuable for increaſing national induſtry; that, by the labours of C. Clouet, the proceſſes of this new art are already determined, in ſuch a manner as to leave no doubt of their ſucceeding in a large manufactory; that the ſteel ariſing from them, when forged in bars, has all the external characters and intrinſic qualities of the Engliſh caſt ſteel of the manufactories of Huntzman and Marſchall; that it may be uſed for the ſame purpoſes, and be introduced in competition with it into commerce, without fear of any diſtinction being made to its prejudice; that it is to be wiſhed, in order to haſten the benefits of this diſcovery, that government would order from 15 to 20 myriagrammes to be manufactured of this ſteel, the value of which, at the preſent

price, would be almoſt equivalent to the expence; that entruſting the management of the firſt trials to C. Clouet, would enſure the beſt ſucceſs; and laſtly, that, in any event, the free and unreſerved communication which C. Clouet has made of this diſcovery, entitles him to the gratitude of his countrymen, and to a national reward.

XII. *Extract of a Report made by* C. PICTET, *of Geneva, to the Society for the Advancement of the Arts eſtabliſhed in that City in regard to the Steel-Yards of* C. PAUL, *From the* Journal des Mines, *No. XLV.*

THE place of inſpector of weights and meaſures, occupied at Geneva by C. Paul, having given him an opportunity of carefully examining a great number of ſteel-yards, he has found reaſon to be convinced that the greater part of theſe inſtruments, and particularly the Roman ſteel-yards, are conſtructed on bad principles, and ſeem to have been made by artiſts unacquainted with the properties of the lever. He has ſucceeded in improving theſe inſtruments, and ſteel-yards in particular. The latter, in the common purpoſes of commerce, have two advantages over balances. 1. That their axis of ſuſpenſion is not loaded with any other weight than that of the merchandiſe, the conſtant weight of the apparatus itſelf excepted; while the axis of the balance, beſides the weight of the inſtrument, ſuſtains a weight double to that of the merchandiſe. 2. The uſe of the balance requires a conſiderable aſſortment of weights, which cauſes a proportional increaſe in the price of the apparatus, independently of the chances of error which it multiplies, and of the time employed in producing an equilibrium. Theſe motives induced C. Paul to employ his thoughts on the means of ſo far improving ſteel-yards, that, either in delicate operations of the arts, or in thoſe of the ſame kind which are often ſo neceſſary in the practice of the phyſical ſciences, theſe inſtruments

ſtruments might be ſubſtituted with advantage for common balances. In order that I may better explain in what the improvements of the ſteel-yards ſubmitted to the Society conſiſt, it will be proper to point out what were the faults of the common ones.

1. There were none of them, in which the points of ſuſpenſion were exactly in the prolongation of the line of the diviſions of the beam; a circumſtance which neceſſarily changed the relation between the arms of the lever, the power and the reſiſtance, according as the direction of the beam was changed from a horizontal poſition. We have ſeen ſteel-yards, in which a degree only of difference in the inclination of the beam produced the difference of more than a pound in the reſult.

2. When the ſhell, the beam, and weight, are made at hazard, a perſon who poſſeſſes a ſteel-yard cannot know when the inſtrument is deranged; and even an artiſt cannot repair it, but by repeated trials, and with a great loſs of time.

3. The conſtruction of the common ſteel-yards, which have a ſmall and a large ſide, renders it neceſſary to invert them frequently: a laborious operation when theſe inſtruments are heavy, and which expoſes the axes to the danger of damage by the effect of the ſhocks which that turning occaſions.

As theſe double ſides renders it neceſſary to have a beam very ſtraight, in order that it may be leſs faulty, it readily bends, which is a new ſource of error; and, the face which bears the numbers being narrow in proportion, it is difficult to form on it numbers ſufficiently viſible. Theſe inconveniences are all avoided by the conſtruction of C. Paul, which preſents, beſides, ſeveral other advantages not poſſeſſed by the old ſteel-yards.

1. The centres of the movement of ſuſpenſion, or the two conſtant centres, are placed on the exact line of the diviſions of the beam; an elevation almoſt imperceptible in the axis of the

the beam, deſtined to compenſate for the very ſlight flexion of the bar, alone excepted.

2. The apparatus, by the conſtruction of the beam, is balanced below its centre of motion; ſo that when no weight is ſuſpended, the beam naturally remains horizontal, and reſumes that poſition when removed from it, as alſo when the ſteel-yard is loaded and the weight is at the diviſion, which ought to ſhew how much the merchandiſe weighs. The horizontal ſituation in this ſteel-yard, as well as in the others, is known by means of the tongue, which riſes vertically above the axis of ſuſpenſion.

3. It may be diſcovered that the ſteel-yard is deranged, if, when not loaded, the beam does not remain horizontal.

4. The advantage of a great and a ſmall ſide (which in the others augments the extent of their power of weighing) is ſupplied by a very ſimple proceſs, which accompliſhes the ſame end with ſome additional advantages. This proceſs is to employ, on the ſame diviſion, different weights. The numbers of the diviſions on the bar, point out the degree of heavineſs expreſſed by the correſponding weights. For example, when the large weight of the large ſteel-yard weighs eighteen pounds, each diviſion it paſſes over on the bar is equivalent to a pound; the ſmall weight, weighing eighteen times leſs than the large one, will repreſent, on each of theſe diviſions, the eighteenth part of a pound or ounce; and the oppoſite face of the bar is marked by pounds at each eighteenth diviſion. In this conſtruction, therefore, we have the advantage of being able, by employing both weights at once, to aſcertain, for example, almoſt within an ounce, the weight of 500 pounds of merchandiſe. It will be ſufficient to add what is indicated by the ſmall weight in ounces, to that of the large one in pounds, after an equilibrium has been obtained by the poſition of the two weights, viz. the large one placed at the next pound below its real weight, and the ſmall one at the diviſion which determines the number of ounces to be added.

5. As

5. As the beam is divided only on one ſide, it may have the form of a thin bar, which renders it much leſs ſuſceptible of being bent by the action of the weight, and affords room for making the figures more viſible on both the faces.

6. In theſe ſteel-yards the diſpoſition of the axes is not only ſuch that the beam repreſents a mathematical lever without weight; but in the principle of its diviſion, the interval between every two diviſions is a determined and aliquot part of the diſtance between the two fixed points of ſuſpenſion; and each of the two weights employed has for its abſolute weight the unity of the weight it repreſents, multiplied by the number of the diviſions contained in the interval between the two conſtant centres of motion. Thus, ſuppoſing the arms of the ſteel-yard divided in ſuch a manner that ten diviſions are exactly contained in the diſtance between the two conſtant centres of motion, a weight to expreſs the pounds on each diviſion of the beam muſt really weigh ten pounds; that to point out the ounces on the ſame diviſions, muſt weigh ten ounces, &c. So that the ſame ſteel-yard may be adapted to any ſyſtem of meaſures whatever, and in particular to the decimal ſyſtem, by varying the abſolute heavineſs of the weights, and their relation with each other. The application of this principle will be ſeen hereafter in the deſcription of the ſteel-yard, to which C. Paul, with great propriety, has given the name of *univerſal ſteel-yard*.

But, to trace out, in a few words, the advantages of the ſteel-yards conſtructed by C. Paul for commercial purpoſes, I ſhall only obſerve, 1. That the buyer and ſeller are certain of the correctneſs of the inſtrument, if the beam remains horizontal when it is unloaded and in its uſual poſition. 2. That theſe ſteel-yards have one ſuſpenſion leſs than the old ones, and are ſo much more ſimple. 3. That by theſe means we obtain, with the greateſt facility, by employing two weights, the exact weight of merchandiſe, with all the approximation that can be deſired, and even with a greater

preciſion

precision than that given by common balances. There are few of these which, when loaded with 500 pounds at each end, are decidedly sensible of an ounce; and the steel-yards of C. Paul possess that advantage, and cost one half less than balances of equal force. 4. In the last place we may verify, every moment, the justness of the weights, by the transposition which their ratio to each other will permit; for example, by observing whether, when the weight of one pound is brought back one division, and the weight of one ounce carried forwards eighteen divisions, the equilibrium still remains.

If, instead of ascertaining the weight of the merchandise in pounds, you wished to find it according to the new system in decagrammes, hectogrammes and kilogrammes, it will be sufficient to substitute, for the ordinary weights, an assortment of three weights bearing the above names. These three weights are the decuple one of the other; and the absolute weight of that called kilogramme, is to the absolute weight of that called pound, in the exact ratio of these two quantities. It may be here seen, that, by adapting to the steel-yard a system of three weights, we may arrive at the second decimal, or the centiemes of the unity of the weights employed, and even without adding or changing any thing in the division of the beam.

It is on this simple and advantageous principle that C. Paul has constructed his *universal steel-yard*, which I am going to describe. It serves for weighing in the usual manner, and according to any system of weights, all ponderable bodies to the precision of half a grain in the weight of a hundred ounces; that is to say, of a decigramme in the weight of a kilogramme, or, in other words, of a ten thousandth part.

It is employed, besides, for ascertaining the specific gravity of solids, of liquids, and even of the air itself, by processes extremely simple, and which do not require many sub-divisions in the weights. This complete apparatus is represented plate X.

The

The beam A B of this ſteel-yard is conſtructed on the ſame principles as the commercial ſteel-yard, but of much ſmaller dimenſions *. The ſhears are ſuſpended by a ſcrew to a croſs bar of wood ſupported by two pillars, which reſt on the two extremities of a ſmall wooden box furniſhed with three drawers, and which ſerves as the ſtand of the apparatus. This beam is divided into 200 parts, beginning at its centre of motion. The diviſion is differently marked on the two faces: on the anterior face the numbers follow each other from 10 to 200, proceeding towards the extremity; and on the other face, repreſented apart at F, the numbers are marked in the oppoſite direction. I ſhall ſoon explain the uſe of this difference in the order of numeration.

The ſmall frame G is deſtined to prevent the oſcillation of the beam, and it is placed at the proper height by means of the nut and ſcrew by which it is ſuſpended. Above the beam is ſeen a ſmall croſs bar of braſs, ſuſpended by its two extremities from the croſs bar of wood. Different weights are hooked to it, each having its particular value marked on it. And, in the laſt place, a ſmall mercurial thermometer having the two moſt uſual diviſions, and deſtined to point out the temperature of the air and the water during the experiments. The axis of ſuſpenſion of the ſteel-yard reſts upon two beds of very hard well-poliſhed ſteel. The caſe is the ſame, but in a reverſed ſituation, with the axis which ſupports the hook C, that ſerves for ſuſpending different parts of the apparatus according to the purpoſe to which it is to be applied.

When you wiſh to employ it as a common ſteel-yard, you ſuſpend from it the braſs ſhell E, which is an exact counterbalance for the weight of the beam when unloaded. The

* A drawing of C. Paul's Commercial Steel-yard was ſubjoined to this memoir. As it was impoſſible to give more plates, we have been obliged to ſuppreſs that figure; but the one we have cauſed to be engraved will give a very correct idea of it, ſince the principles of the conſtruction of both the large and ſmall ſteel-yards are abſolutely the ſame. *Note of the French Editor.*

latter

latter then aſſumes of itſelf a horizontal ſituation. You then ſearch for the equilibrium of the ſubſtance put into this ſhell, by placing at the proper place, on the beam, the weight and its fractions correſponding with the ſyſtem of weights adopted; and when you have found the equilibrium, you obſerve the weight indicated by the diviſions on which each of the weights employed is found, exactly in the ſame manner as is done in regard to the common ſteel-yard.

There may be ſeen in the plate a glaſs ſhell ſuſpended in a jar filled to a certain height with water. This ſhell is deſtined for experiments in regard to the ſpecific gravity of ſolids. It is in equilibrium, if, when immerſed into water at 12° R, as far as the junction of the three ſilver wires by which it is ſupported, it exactly balances the weight of the beam unloaded.

When you wiſh then to try the ſpecific gravity of a ſolid, you firſt weigh it in air; but by putting it into the braſs ſhell, and then ſubſtituting the glaſs one, you weigh it in water. It is well known that the difference of theſe weights, employed as a diviſor of the total weight in air, gives for quotient the ſpecific gravity. Care muſt be taken, as in all experiments of the kind, that no bubble of air adheres to that part of the apparatus immerſed in the water, or to the ſubſtance, the weight of which is required, and which is immerſed alſo.

The ſolid glaſs ball H is deſtined for the purpoſe of aſcertaining the ſpecific gravity of liquids, in the following manner:—This piece is furniſhed with a hook of fine gold, that it may be immerſed without inconvenience in acids. When it is ſuſpended to the hook of the ſteel-yard, and in the air, it is in equilibrium with the beam loaded at its extremity (either at the diviſion marked O, on the ſide of the beam ſeen at F) with weights entitled *ſpecific*, and $\frac{1}{100}$ of ſpecific hooked on at the other.

This ball, immerſed in diſtilled water at 12° R. as far as the end of the ſtraight metal wire which ſuſpends it, is ſtill in equilibrium with theſe two weights placed in the following manner, viz. the large one at the diviſion in the middle of

the

the beam marked *water* on the ſide F of the beam, and the ſmall one at the diviſion O, that is to ſay, the extremity. When the apparatus is thus prepared, you fill a jar with the liquid, the ſpecific gravity of which you wiſh to aſcertain; ſuſpend the *ball* H to the hook of the ſteel-yard, and immerſe it into the liquid till it riſe exactly above the ring from which the ball hangs, obſerving the temperature, and diſengaging carefully all the air bubbles that may adhere to the ball; then remove the ſmall weight to the diviſion O at the end of the beam, and convey the large one as far as that diviſion, preceding that where the weight of the ball would raiſe the beam; and afterwards move the ſmall weight as far as the diviſion where the equilibrium will be reſtored, the beam being horizontal. Mark the diviſion at which the large weight is found, and add two cyphers; to this number add the indication immediately reſulting from the poſition of the ſmall weight, and the ſum of theſe two numbers gives the ſpecific gravity of the liquid, or its ratio with the weight of diſtilled water to a ten thouſandth part.

The balloon N is deſtined for trying the weight of any given kind of gas compared with that of atmoſpheric air, in the following manner:—The weight entitled *air tare* is arranged in ſuch a manner that when placed in the notch, ſeen at the extremity of the beam beyond the diviſions towards B, it forms an equilibrium with the balloon exhauſted by the air-pump and ſuſpended from the hook of the ſteel-yard. If the ſteel-yard is not then in equilibrium, it is a ſign that the inſtrument is deranged, or that the vacuum is not perfect. The air, the relative weight of which in regard to atmoſpheric air you wiſh to aſcertain, is to be introduced into the balloon, and the weight marked *air* is to be moved along the beam. The diviſion at which it ſtands when an equilibrium is produced will indicate, in hundredth parts of the weight of the volume of atmoſpheric air that could be contained in the balloon, the weight of the gas actually incloſed in it.

This

This indication is read on the anterior part of the beam, where the words *atmoſpheric air* are marked.

Not ſatisfied with having procured to philoſophers, and thoſe fond of accurate experiments, an inſtrument extremely convenient for the cloſet, and of very extenſive uſe, C. Paul has endeavoured to render this apparatus portable, and has conſtructed various pocket ſteel-yards, with which the niceſt experiments may be made, and the quality of gold coin be aſcertained by the trial of its ſpecific gravity. They are conſtructed exactly on the ſame principles as the Roman ſmall ſteel-yard, but are neceſſarily leſs extenſive in their uſe. They cannot be employed, for example, in determining the ſpecific gravity of an aëriform fluid, and do not extend beyond 100 deniers of weight, (about 120 grammes;) but as they poſſeſs all the advantages of a balance, beſides thoſe peculiar to themſelves, they are extremely convenient for philoſophers who are obliged to travel.

EXPLANATION OF THE PLATE.

A, B, the beam of C. Paul's ſteel-yard with its diviſions, commencing at the point of ſuſpenſion. F, diviſion of the other ſide of the ſame beam, commencing at the other extremity, or that fartheſt diſtant from the point of ſuſpenſion. G, a ſmall frame deſtined to prevent the oſcillation of the beam. C, a hook from which the weights are ſuſpended. E, a braſs ſhell or baſon. H, a ball of ſolid glaſs for trying the ſpecific gravity of liquids. N, a glaſs balloon for trying the ſpecific gravity of gaſes.

XIII. *A new, eaſy, and cheap Method of impregnating Water with Carbonic Acid Gas. Communicated by Dr.* A. N. SCHERER, *Counſellor of Mines to the Duke of Saxe Weimar.*

DR. FIERLINGER has propoſed the following very ſimple method for impregnating water with carbonic acid

gas. He fills common round bottles with water, inverts them carefully under water in order to prevent any air from entering, and charges them in the uſual method with carbonic acid gas. He then corks the bottles, thus filled, under the water, with a ventilated ſtopper, immerſes them under water in a proper cylindrical, almoſt tubular ſhaped veſſel, 2 feet high, and of a proportionate width to the diameter of the bottle, in order to apply, by means of hydroſtatic laws, a great preſſure with a ſmall quantity of water. The bottles thus filled with the gas, and entirely immerſed, imbibe water by means of the affinity the carbonic acid gas has for it, in ſuch a manner that they are nearly filled; and water is thereby obtained, impregnated with an equal volume of gas, the water having lodged itſelf in the interſtices of the gas. It is pretty ſtrong, and can be made ſtill more ſo. This method has, beſides its conveniency and cheapneſs, ſtill other advantages; the degree of impregnation may be regulated by the height of the column of water under which the bottle is immerſed, and the water is prepared in thoſe veſſels out of which it is to be drank, and this prevents that eſcape of gas which always takes place when poured from one veſſel to another, eſpecially if the water be ſtrongly impregnated. The above-mentioned ventilated ſtoppers are corks fitted exactly to the bottles, perforated length-ways, by holes drilled through them, the uppermoſt orifices of which are covered with a ſmall plate of pewter, faſtened to the cork by means of a ſtring paſſed through a hole in the centre, and drawn through the cork. If this ſmall plate be furniſhed with a little cavity, in which iron filings are put, the water becomes chalybeate.

XIV. *Fifth Communication from Dr.* THORNTON, *Phyſician to the General Diſpenſary, relative to Pneumatic Medicine.*

A CASE OF ST. ANTONY'S FIRE CURED BY VITAL AIR.

MISS GOUDY, æt. 18, living No. 171, High-ſtreet, Shadwell, had been ſubject to occaſional attacks of this diſeaſe for eight years paſt. In one attack, ſome years ago, a ſkin formed over the right eye, which was removed by a cauſtic powder blown into it by order of Mr. Sharp, and ſight was reſtored in about a month: this eye has, however, ſince been ſubject to become inflamed upon the leaſt cold, when the face enlarges prodigiouſly, looks red as fire, with intenſe burning. She had taken a great quantity of medicine under Meſſrs. Young, Ward, Evans, &c. without any marked advantage, previous to her parents making application to me. When I ſaw her, her right eye was much inflamed, and the upper lips and cheeks were tumefied in a frightful degree. It was a new caſe, that required much conſideration. Were the veſſels in a ſtate of inflammation from tone, or from debility? Examining the arms I found them remarkably blue and mottled, the feet were always uncommonly cold, the appetite craving, or elſe none, very flatulent, great diſtention of the abdomen at times, and a tendency to chloroſis. The pulſe ſmall, and quick. I accordingly ordered the ſuper-oxygenated air, November 27, 1798, gradually augmenting its power. Memorandum—December 4, Feels always a great glow over the whole body, after inhaling the vital air. Inflammation of the eye gone. I ordered a ſeton in the neck, to hinder a relapſe, by its inviting the blood to a neighbouring part, and ſetting up a new action: and without fear I now purſued the tonic and ſtimulant plan, viz. bark, myrrh, and ſteel, and a ſuper-oxygenated air *; and my fair patient was ſoon perfectly cured, and continues ſo, I am happy to ſay, to this day.

* The proportion was generally ſix quarts vital air mixed with twenty of atmoſpheric.

INTEL-

INTELLIGENCE,

AND

MISCELLANEOUS ARTICLES.

LEARNED SOCIETIES.

GERMANY.

THE following queſtion has been propoſed as the ſubject of a prize by the Royal Society of Gottingen, to be anſwered before the firſt of November 1800.

As it has been aſcertained by numerous experiments that a great quantity of vaporific *(caloris vaporifici)*, or, as it is called, latent heat, is carried off by the ſteam of water, boiling in an open veſſel, and ſoon diſperſed, which, however, if carefully collected through tubes and pipes properly diſpoſed, might be of great utility in various purpoſes in economy and manufactures, the Society embraces this opportunity of requeſting mathematicians and philoſophers to turn their attention to this ſubject, and to endeavour, as far as poſſible, to eſtabliſh a more accurate theory than any yet given of the motion of ſteam.

The Royal Society requires, therefore, I. An inveſtigation, both by experiment and calculation, of the laws, or at leaſt the general laws, of the ſteam of boiling water paſſing through tubes of a certain length and ſize; the matter of the tubes and the degree of heat of the ſurrounding medium being given, as well as other data which it is not neceſſary to mention to thoſe acquainted with the nature of this elaſtic fluid.

II. When theſe laws are in ſome meaſure eſtabliſhed, to deduce from them what degree of heat can be communicated, in a given time, by a given quantity of ſteam thus conveyed through tubes, with a given quantity of cold water, or water of any given temperament.

The Electoral Jablownſki Society of the Sciences, at Leipſic, have propoſed the following queſtions, as the ſubject of a prize for the year 1799:

HISTORY. An explanation, proved by authentic documents, of the origin, rights and principal deſtination of the dignity of Earl in the northern kingdoms.

MATHEMATICS. A more accurate determination, compared with experience, of the laws of reſiſtance to fluid bodies impelling in an oblique direction.

PHYSICAL-ECONOMY. Application of our preſent knowledge reſpecting the different kinds of air, particularly to phyſics and economy.

The prize is a gold medal of the value of 24 ducats. No papers will be received but ſuch as are written in French or in Latin; and they muſt be accompanied with a ſealed note, containing the author's name and place of reſidence.

The following is an account of the Sittings of the Academy of Sciences of Berlin, in the year 1798:

On the 11th of January M. Selle read a German memoir on natural right; and on the 18th M. Erman read one in French on literary blunders, and their influence on biography.

In the public ſitting of Jan. 25th, M. Achard read, in French, an account of ſome experiments made with a view to determine the influence of compreſſed air on the germination of ſeeds, and its action on animal life, with the deſcription of a new method of injecting the veſſels of plants which are capable of receiving a fluid within them.—M. Denina read a French memoir on the ancient traces of the character of the Germans, followed by a ſhort compariſon between Marcus Aurelius and Frederic II.—M. Klaproth, a German memoir on the gold ore of Tranſylvania, and the new metal it contains.—M. Baſtide, Reſearches, in French, on the word *environ*.—Count de Guyon, an hiſtorical view, in French, of the influence which women have had over the great actions of their age and country. This formed the third epoch.

On the 1ſt of February M. Wildenow read, in German, an eſſay on a new claſſification of the *mammiferæ*.

On the 8th M. Bode communicated ſeveral articles of intelligence from his aſtronomical correſpondents. He preſented alſo a memoir on the orbit of the comet obſerved at Berlin in 1797, which contained ſome reſults reſpecting its real courſe.

On the 15th M. Caſtillhon, Reflections, in French, on the ſenſes in general, and particularly on the organs of the internal ſenſe.

On the 22d M. Gedike, a paper, in German, on the reciprocal influence of civiliſation on writing, and of writing on civiliſation.

On the 8th of March M. Burja communicated a paper, in French, on the progreſs of light paſſing through a tranſparent priſm, with an application to achromatic priſms, and achromatic teleſcopes.

On the 15th M. Ancillon preſented a French memoir on preſenſation.

On the 22d M. Baſtide preſented, in French alſo, various obſervations on the French language, in regard to different paſſages of Montaigne, with ſome critical remarks on that author.

On the 29th M. Walter, the ſon, read a German memoir on the ſkin.

On the 19th of April M. Bode preſented the eight firſt ſheets of his celeſtial chart.

On the 3d of May M. Teller preſented a paper, in German, on moral puriſm and empiriſm, and the ideas which ought to be formed of them.

On the 10th M. Cuhn, a paper, in German, on the hiſtory of the origin of the Germanic conſtitution.

On the 7th of June M. Achard, a German memoir, containing reſearches on the germination of ſeeds, and the growth of plants.

On the 14th M. Gruſon, a paper, in French, on a new calculus, which he calls *calcul d'expoſition*.

On the 21ſt M. Bieſter, a paper, in German, on the principle of Socrates, that virtue and knowledge (φρονησις et επιστημη) are the ſame thing.

On the 28th M. de Verdy, an hiſtorical chronology, in French, of the Margraves of Brandenbourg, Anſpach, and Bayreuth, deſcended from the electoral houſe of Brandenbourg, and who have exiſted ſince the year 1486 to the preſent time.

On the 2d of Auguſt M. Achard, a continuation of his experiments on the germination of ſeeds, &c.

On the 9th of the ſame month the academy held a public ſitting, in which the following papers were read:—M. Achard gave an account of the experiments he had made to determine the influence of the coloured rays of light on the germination of ſeeds, the green colour of plants and their decay, and alſo to aſcertain the different degrees of the affinity of oxygen with luminous rays differently coloured. He ſhewed, at the ſame time, the apparatus which he employed, as well as the reſults of his experiments.—M. Erman read a memoir on the order of ſucceſſion in the houſe of Pruſſia and Brandenbourg, ſince the reign of the branch of Hohenzollern.—Count de Guyon read the fourth period of his hiſtorical view of the influence of women on the great events of their age and country. The ſitting was terminated by a memoir of the marquis de Boufflers on literature and literary men.

HOLLAND.

The Batavian Economical Society, authoriſed by the Directory of the Batavian republic, has propoſed the following queſtion as the ſubject of a prize, to be anſwered either by natives or foreigners:

Are there any means hitherto unknown, and ſufficiently effective, to reſtore ſo completely, without the mixture of pernicious ingredients, the taſte and ſmell of ſtinking and corrupted water, as to render it a pure, cooling, and wholeſome beverage? And what are theſe means?

A ſatis-

A ſatisfactory anſwer to this queſtion will entitle the author to a prize of 6000 florins. In the anſwer care muſt be taken, 1ſt, That the means be not too expenſive, or attended with too much trouble; that they do not occaſion too great a conſumption of fuel; and that they can be employed at ſea, on board veſſels heavily laden, and often expoſed to violent agitation.—2d, That the means do not require too much art, and may be eaſily applied, even by ſeamen.—3d, That they be proved by experiments capable of producing the ſame effects in every temperature.—4th, That they be not hurtful, by corroding the copper veſſels in which ſhip's proviſions are boiled, or in any other manner.

If the inventor of ſuch means, after aſcertaining their effect, will communicate his ſecret, without concealing any part of it, to the commiſſioner of the Society, ſo that it may be ſubjected to trial in any determined place or ſhip, and if it ſhall be found to anſwer after ſeveral experiments, he will receive a third part of the premium. The reſt of the ſum will be paid as ſoon as the Society have been convinced of the certainty of the reſult of theſe means, by experiments made in different climates, and by the opinion of competent judges.

The Society, however, retains to itſelf a right of dividing the prize among ſeveral competitors, ſhould the means propoſed by each be equally efficacious.

The papers are to be tranſmitted, with the uſual formalities, addreſſed to C. J. J. Deſſout at Harlem, Secretary General to the Batavian Society, before the 28th of February 1800.

SWISSERLAND.

The Economical Society of Berne, having received no ſatisfactory paper on the means of extirpating a deſtructive kind of moth, common there, which not only attacks woollen but alſo ſilk, and is particularly deſtructive to furniture ſtuffed with horſe-hair, for which they offered a prize of 20 ducats in the years 1796 and 1797, again repeat the ſame queſtion, and extend the time for receiving anſwers to three years.

The Society expect—1ſt, That the candidates will determine accurately whether this inſect be the *tinea veſtionella*, *pellionella*, *tapetzella*, or *ſarcitella* of Linnæus, or different from theſe.—2d, A circumſtantial natural hiſtory of it.—3d, An examination, founded on experience and ſcientific principles, of the efficacy of all the means hitherto propoſed for extirpating it.—And laſtly, A propoſal, founded on experience and trials made, of means by which the deſtruction occaſioned by theſe peſts may in future be prevented. Papers on this ſubject may be tranſmitted to the Society any time before the 1ſt of January 1802.

FRANCE.

In the public ſitting of the National Inſtitute on the 4th of January, the following report was read of the labours of the Claſs of the Phyſical Sciences during the preceding quarter.

Among the various objects which for three months have occupied the Claſs of the Phyſical Sciences, were two new kinds of plants preſented by C. Lheritier. The firſt, diſcovered at Madagaſcar by C. Bruguiere during his voyage round the world with Kerguelen, will be diſtinguiſhed by the name of *Bruguiera*. The ſecond, diſcovered at the Iſle of France by the ſame botaniſt, belongs to the family of the Orchis; as it is a paraſite plant that entwines itſelf around the trunks of trees, C. Lheritier means, on that account, to call it *Rhizodendrum*.

There is a tree, originally from America, the young branches of which, while in a ſtate of vegetation, are covered with a viſcous matter, which, however ſlightly touched, adheres ſtrongly to the fingers, and renders them black. C. Vauquelin conſiders it as a principle different from all thoſe known in the vegetable kingdom; but which approaches nearer to the gums than to any other ſubſtance. The production of this ſort of gum has made the name of *Robinia viſcoſa* be given to the tree in queſtion, to diſtinguiſh it from another *robinia*, or falſe acacia, to which it has a great reſemblance.

ſemblance. C. Cels and Ventenat have ſhewn that this tree belongs to a ſpecies deſcribed by C. Juſſieu and Lamarck. We are indebted to C. Mechaut, aſſociate of the Inſtitute, for this new acquiſition, ſtill more important perhaps than that of the falſe acacia, which is at preſent cultivated with ſo much advantage.

The difficulty of collecting the various productions of different climates, has been juſtly conſidered as one of the greateſt obſtacles to the ſtudy and progreſs of natural hiſtory. This difficulty no longer exiſts in regard to the plants growing in the territories of Tunis and Algiers. The public is now in poſſeſſion of a *Complete Flora of Mount Atlas*, ſo long wiſhed for by botaniſts; and we are indebted for that obligation to C. Desfontaines.

C. Brouſſonet, whom the love of ſcience conducted to the ſame part of Africa, has given an account of the particular proceſſes employed at Fez and Tetuan, for preparing thoſe goat ſkins of which morocco leather of different colours is manufactured.

C. Teſſier has ſhewn how beneficial it would be to encourage, in the maritime provinces of France, the manufacturing of pitch-rope paper, ſuch as that uſed for ſheathing of ſhips, by employing oakum procured from old ropes, &c.

The ſame author has obſerved a ſingular fact, the cauſe of which is not yet known. He obſerved, in ſeveral places, milk newly drawn from the cow, and of a beautiful white colour, to become blue in the courſe of two or three days, and remain ſo even after it had been boiled. We are aſſured that this phenomenon does not depend either on the age or health of the cows, on the dairies, the veſſels in which the milk is preſerved, nor on any want of care or cleanlineſs. The whole produce of the milk, though blue, is of a good quality, and may be ate without any inconvenience. It is not improbable that this colour may be owing to ſome plants of the nature of woad or indigo, on which cows ſometimes feed in ſummer. But this is only conjecture; and C. Teſſier

propoſes,

propoſes, with a view of diſcovering the truth, to make the neceſſary reſearches and experiments in thoſe places where the phenomenon has been obſerved *.

In a memoir on a new claſſification of ſhells, C. Lamarck has ſhewn the neceſſity of increaſing the number of genera, and of abridging the characters by which they are diſtinguiſhed. This number he carries to a hundred and ſeventeen. Linnæus and other naturaliſts made it only ſixty. By means of this claſſification, we may more eaſily reduce to its particular genus, all the teſtaceous animals with which we wiſh to be acquainted.

In the numerous family of the ſpiders there are ſome called miners and maſons, becauſe they conſtruct for themſelves ſubterranean cavities or galleries, which they ſhut with a kind of trap-door. C. Latreille, aſſociate of the Inſtitute, has pointed out the characters peculiar to this induſtrious family, and the means of preventing their being confounded with other inſects of the ſame name, but of a different ſpecies.

It is well known that phoſphorus, and ſeveral ſaline combinations of the phoſphoric acid, have been found by chemiſts in urine. By new reſearches C. Fourcroy and Vauquelin have diſcovered, in that liquid, alumine and the phoſphat of magneſia. They have ſeen that a peculiar animal matter, by which urine is characteriſed, and which gives it all its properties, forms there, very ſpeedily, ammonia, which makes the phoſphat of magneſia paſs into the claſs of triple ſalts, renders it much leſs ſoluble than before, and ſuſceptible of being precipitated in laminæ or cryſtalline needles. Theſe two chemiſts have given an account of the ſpontaneous changes it experiences, and ſhewn that the examination of

* There ſeems more reaſon for ſuſpecting it to be Pruſſian blue, the ingredients of which are furniſhed by all red blooded animals. We may obſerve, however, that it is a known fact that cows which eat the madder plant, give milk that has the appearance of being ſtreaked with blood. EDIT.

It,

it, ſcarcely begun, is one of thoſe objects which are highly deſerving of the attention of phyſicians, ſince it affords the means of reſolving one of the moſt important problems in regard to the phyſical condition of man, either in a ſtate of ſickneſs or health.

The obſervations of C. Beaumé on the decompoſition of the muriat of lime by lime (muriate calcaire par la chaux), and his reſearches in regard to a diſeaſe called by phyſicians the black bile, the cauſes and effects of which have been explained by C. Portal, in pointing out the remedies by which it may be cured, have likewiſe engaged the attention of the claſs of the phyſical ſciences.

ROYAL SOCIETY OF LONDON.

On the 5th of April the meeting was occupied with the reading of a paper on animal electricity, by Dr. Yeats. On the 12th and 18th a long paper on the Andaman Iſlands, by Capt. Blair, was read. On the 25th, ſome farther obſervations on hermaphrodites, by Everard Home, Eſq. On the 2d and 9th of May, an ingenious paper by Count Rumford, on the weight of caloric, in which he repeats Dr. Fordyce's experiments, but with various reſults; and concludes, from all the experiments, that heat is imponderable. On the 9th there was alſo read a paper on the fecundation of plants, by Thomas Andrew Knight, Eſq. On the 23d, and 30th, a paper on the different kinds of Aſiatic elephants, with obſervations on their tuſks and teeth, by John Corſe, Eſq.

DISCOVERIES IN AFRICA.

The following notice, on this ſubject, by Lalande, has appeared in one of the French Journals:

"Sir Joſeph Banks, preſident of the Royal Society of London, has received intelligence from Horneman at Grand Cairo. His laſt letter was dated the 31ſt of Auguſt. Bonaparte offered him money. He ſet out with the caravan of Fezzan

Fezzan on the 12th of September, with camels, horſes and ſome merchandiſe. He aſſumes the character of a merchant, but not very rich, that he may not afford temptation to avarice. When in Egypt he accidentally met with a countryman of his own, who had long reſided there, and embraced the Mahometan religion. He had made three journeys to Mecca, and ſpoke the Turkiſh and Arabic languages with great fluency. He was on the point of returning to Europe; but, at the requeſt of Horneman, he conſented to accompany him on his journey. Horneman means to proceed to Fezzan, and thence to Caſhna. He will remain as long as he can in the interior of Africa; and return either towards the weſt by Senegambia, or towards the eaſt by Ethiopia. He ſtill enjoys good health; has withſtood the climate of the country, and is filled with zeal and ardour. His letter to Sir Joſeph Banks bore the impreſſion of Bonaparte's official ſeal, and was delivered to Sir Joſeph by the French agent in England for the exchange of priſoners. Sir Joſeph, in Von Zach's Ephemerides for February, does juſtice to the French by a compliment for the ſcrupulous delivery of this letter."

The following is an extract of a letter from *M. Hornſman* to *Profeſſor Heeren* at Gottingen, dated Cairo, October 14, 1797.—" I am as well at preſent as can be expected; my health has not in the leaſt ſuffered from the climate, though it is very different from that of Europe. I have not yet been able to examine thoroughly the ruins of Alexandria, becauſe there are too many of the free Arabs roving about the city. But, in order that I might not be idle, I examined the different kinds of ſtones, and carried away ſpecimens. It was no part of my plan to make reſearches into the antiquities in the neighbourhood of Cairo, until I had ſtudied the language of the inhabitants. As I had a good opportunity, however, to viſit the pyramids of Giza, I did not neglect it; and though the ſhortneſs of the time I could employ would not allow me to make many new obſervations, I received this benefit

benefit from the excurſion, that I am better acquainted with the country, and the eaſieſt method of travelling through it.

" I firſt aſcended the great pyramid, and had got about a ſixth part of the way towards the ſummit, when I was obliged to return that I might not detain my companions, M. Hope and Major Schwarz, who wiſhed to enter it. This, however, we found impoſſible; becauſe the entrance was choked up with ſand, which it was neceſſary to remove. That we might not loſe time, I propoſed to Major Schwarz to take a walk through the neighbouring diſtrict, to examine the different kinds of ſtones. This we did with as much ſpeed as poſſible, and returned in about an hour and a half. Before we came back M. Hope had been at the ſarcophagus, but had again come out and returned to the veſſel, which lay at the diſtance of about ten minutes walk from the large pyramid.

" I now intend to go back with two of Murad Bey's people, and to take a complete plan of all the pyramids, with the ſurrounding diſtrict, and a ſection of theſe edifices alſo, if poſſible; to go ſomewhat farther than other travellers have done; and, above all, to examine the ſprings in the large pyramid, which I conſider to be difficult, but not impoſſible.

" Juſt now (Oct. 1797) is the beſt time for travelling in Egypt. Peace every where prevails, for all are afraid of Murad Bey. An Engliſhman of the name of Brown ſeems to have taken advantage of this favourable period. Before he proceeded to *Darfoor*, he had been in Upper Egypt; at *Siwah* (the ancient temple of Jupiter Ammon), and the Lake Natron. He remained above two years at *Darfoor* without being able to procure leave to return, until he at length obtained it by an accident. People here ſay that he obſerves great ſilence, and therefore they ſcarcely know any thing of his diſcoveries.

" There is at preſent an Abyſſinian biſhop here, of whom I have made ſeveral enquiries reſpecting Bruce. He informed me,

me, that an Engliſhman, *Jacobo Bruce*, had been in Abyſſinia; that he was in great favour with the king and nobles of the country; that he frequently obſerved the ſun with an inſtrument like that uſed by ſeamen; that he often aſked reſpecting the *Sources of the Nile*, and that he at length undertook a journey thither. The biſhop ſaid that he had not been acquainted with this traveller himſelf; but that his father had known him perſonally, and had frequently ſpoken of him. This worthy biſhop, therefore, has cleared Bruce of the accuſation made againſt him, that he had never been at the ſources of the Nile."

Under the head of diſcoveries in Africa, we are happy to announce, that the Public will ſoon be gratified with an account of Mr. Brown's travels into that little known quarter of the world. Mr. Brown ſome years ago went from Cairo to *Seewah*, and in the ruins of *Oaſis* there found the remains of a remarkable chapel, which he conjectures, and with ſome probability, to have belonged to the celebrated temple of Jupiter Ammon. He afterwards went along with the *Soudan* caravan, and paid a viſit to the *Great Oaſis* or *Alwah*, to which no European before him had ever penetrated; and which is laid down very accurately in Major Rennel's map, publiſhed in the *Proceedings of the African Aſſociation*. Mr. Brown then travelled through a deſert of conſiderable extent, and at length arrived at *Darfoor*, in 15° 15′ north latitude, which ſtands a little to the eaſt of *Haraza* on the map above-mentioned. Here he found two cities, lying at the diſtance of two days journey of a camel from each other. One of them was the king's reſidence; the other was inhabited by merchants. In the latter of theſe cities he remained two years and ten months in an unpleaſant ſituation, as he was often ordered to attend at court, and was not ſuffered to go to any diſtance from his habitation; owing to an accident, however, he at length found means to depart, and returned by the way of Egypt and Syria.

ASTRONOMY.

The tranſit of Mercury over the ſun's diſk is a phenomenon of the utmoſt importance to aſtronomy, as it affords the means of improving the theory and tables of that planet; but the late phenomenon of this kind, which took place on the 7th of May, was deſerving of the more attention, as a tranſit of Mercury at the deſcending node of his orbit had never been obſerved in its whole duration. Theſe tranſits, in general, are much more uncommon than thoſe at the aſcending nodes. Ever ſince mankind began to view the heavens, Mercury had been obſerved only three times under the like circumſtances, and unfortunately each obſervation was incomplete. In the year 1661 the ingreſs of the planet into the ſun was ſeen, but not its egreſs; and in the years 1753 and 1786 the egreſs only was obſerved. It is much, therefore, to be wiſhed that the weather had been more favourable during the late tranſit, as the ſame phenomenon, under the like circumſtances, will not occur before the year 1832. According to an obſervation made by a gentleman at Greenwich, on this tranſit, on Tueſday the 7th, with a ſeven feet teleſcope by Dr. Herſchel, the aperture of which was contracted, the internal contact with the SW limb of the ſun happened at $4^h\ 28'\ 32''$, and the egreſs at $4^h\ 31'\ 24''$ p. m. mean time. The ingreſs was not ſeen on account of the cloudineſs of the morning.

Mercury has at all times afforded much occupation to aſtronomers; becauſe, to obſerve that planet, is a matter of conſiderable difficulty. The great Copernicus died without ever having ſeen it, and therefore could believe only in its exiſtence. The celebrated Maeſtlinus, the tutor of the immortal Kepler, uſed to ſay that this planet was calculated only to expoſe aſtronomers to the danger of loſing their reputation: ſo that when he knew of any one employed in tracing out its intricate courſe, he adviſed him to employ his time on ſome

better

better object. Riccioli calls Mercury a falſe deceitful ſtar (*ſidus doloſum*), the eternal torment of aſtronomers, which eluded them as much as the terreſtrial mercury did the alchemiſts *. Lalande, that reſpectable veteran of aſtronomy, who has forty-ſix years engaged with this celeſtial rebel, in his laſt treatiſe on it, in the firſt volume of the Tranſactions of the National Inſtitute, calls its courſe *une orbite inextricable*. On account of this planet he ſtudied the Greek language, that he might be able to read the old obſervations in Ptolomy's Almageſt in the original, and, of courſe, to explain them better; and in the younger part of his life he uſed to get on the tops of the houſes, before ſun-riſe, to have a view of Mercury above the foggy horizon of Paris. It is natural, therefore, to ſuppoſe, that, after ſo much labour and exertion, Lalande would have given the beſt tables of Mercury; and this was really the caſe, ſo far as they ſurpaſſed in accuracy the old tables of Halley and Caſſini. He waited, therefore, with anxious expectation for the tranſit of this planet over the ſun's diſk on the 4th of May 1786. His obſervations on that occaſion were to be the touchſtone of his tables, and to reward him at length for the inceſſant pains and labour he had beſtowed on them for nearly half a century. The treacherous Hermes, however, inſtead of ſanctioning theſe tables, proved that the author had erred more than half an hour †. Since that time Trieſnecker of Vienna, and lately Oriani of Milan, have employed themſelves on this planet: and as the laſt, in particular, firſt calculated the per-

* *Almageſtum*, p. 563: Nemo planetarum—Mercurio implicatior eſt —adeo ut cœleſtis Mercurius non minus Aſtronomos torſerit, quam terreſtris Alchemiſtas eludat. And in another place, p. 498, he ſays—Non minoribus quippe ſpirarum involucris vaferrimus planetarum ſuffuratur ſe hic Hermes Aſtronomorum conatibus, quam caduceus ipſius torruoſis anguium circumflexibus.

† Lalande's own words are—*Une erreur de plus de demi-heure vint me donner un démenti.*

turbation,

turbation, according to La Place's theory; Lalande, in the year 1796, improved his elements of Mercury's orbit, and publiſhed them in the *Connoiſſance des Tems* for the year VII, in the certain hope and expectation that he had at length overcome this intractable planet, and could with Virgil exclaim: *Reſpexit tamen et longo poſt tempore venit.*

Much, however, was ſtill wanting; and we are happy to inform thoſe fond of aſtronomy, that a reſpectable aſtronomer, Major von Zach, has juſt announced a complete new ſet of tables of Mercury, in which not only the perturbations of Venus, calculated by Oriani, but thoſe alſo occaſioned by the earth in Mercury, and which Oriani has omitted, will be taken into account. An exalted amateur of aſtronomy is employed in calculating them, and they will be printed at his expence. Major von Zach informs us alſo, that he will have the pleaſure of tranſmitting them to all the aſtronomers in Europe. As theſe tables are not intended for the bookſellers' ſhops, every perſon fond of aſtronomy, who wiſhes to procure a copy of the work, will receive one gratis, on applying to Major von Zach at Gotha.

BOTANY.

A ſingular and ingenious method of multiplying the tongue-leaved eucomis or fritillary (*Fritillaria regia*, L.) is deſcribed in Profeſſor Hedwig's Collection of Memoirs and Obſervations on Subjects of Botany and Economy. This fritillary is called, by Lamarck, *Baſile à epi couronné*. When this beautiful plant of the lily kind is in full flower and vigour, the flowers, leaves, and the upper part of the bulb muſt be cut, and wrapped up in ſeveral folds of ſized writing paper, ſo that the whole be exactly covered. They are then to be moderately compreſſed between two pieces of board; and at the end of ſome months ſeveral ſmall bulbs will be ſeen formed at the lower extremity. I cultivate, ſays C. Willemet, who has made known the above obſervation,

this charming unilobed plant in the national botanic garden at Nancy. It requires to be kept during winter in the hot-houſe.

MEDICINE.

Doctor Lentin, a celebrated phyſician of Germany, has lately publiſhed, in the Tranſactions of the Royal Society of Gottingen, ſome obſervations on Caries of the Bones, and the cure of that diſeaſe. In his opinion it depends on a chemical decompoſition of the phoſphat of lime, produced by the putrefaction of the gelatinous matter contained in the bones. In conſequence of this idea, he was authoriſed to believe that the phoſphoric acid adminiſtered externally might be uſeful in that diſeaſe; and experience, from what he relates, ſeems to confirm it. He gives internally from ten to twenty drops in any proper vehicle; and externally, one part of the ſame acid with ſeven parts of diſtilled water. He ſays, he obſerved that the peculiar fetid odour of carious bones was in a little time removed, and that a cure ſpeedily followed. He, however, adds, that perſons afflicted with hemorrhoidal ſymptoms, as well as women when ſubject to their courſes, were a little irritated by this remedy.

Knakſted has publiſhed, in the Memoirs of the Inſtitute of Peterſburgh, for the treatment of the ſick, that the root of common elecampane (*Inula helenium*), given both internally and externally, is a very efficacious remedy for tetters, the itch, and other cutaneous diſeaſes.

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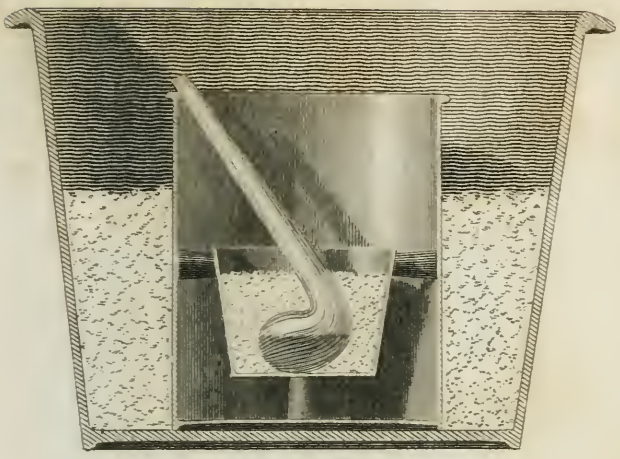

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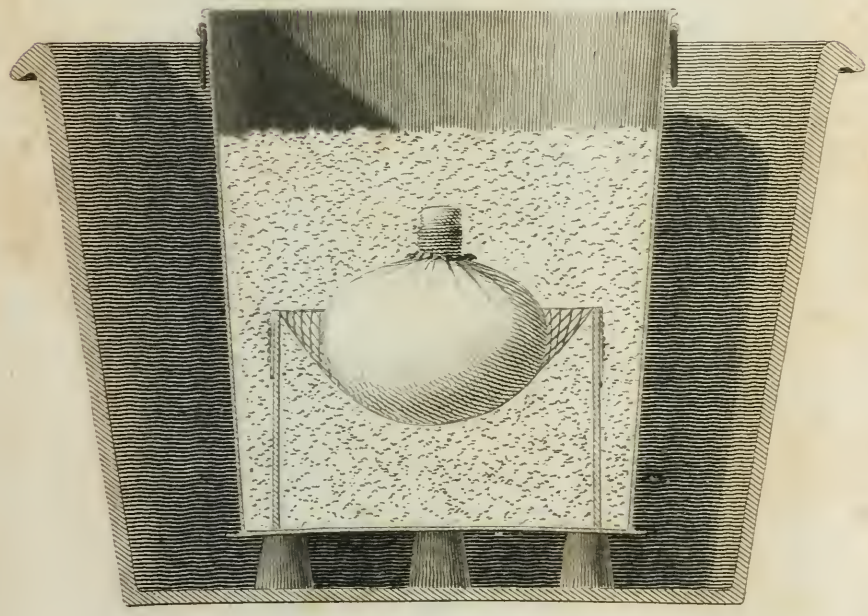

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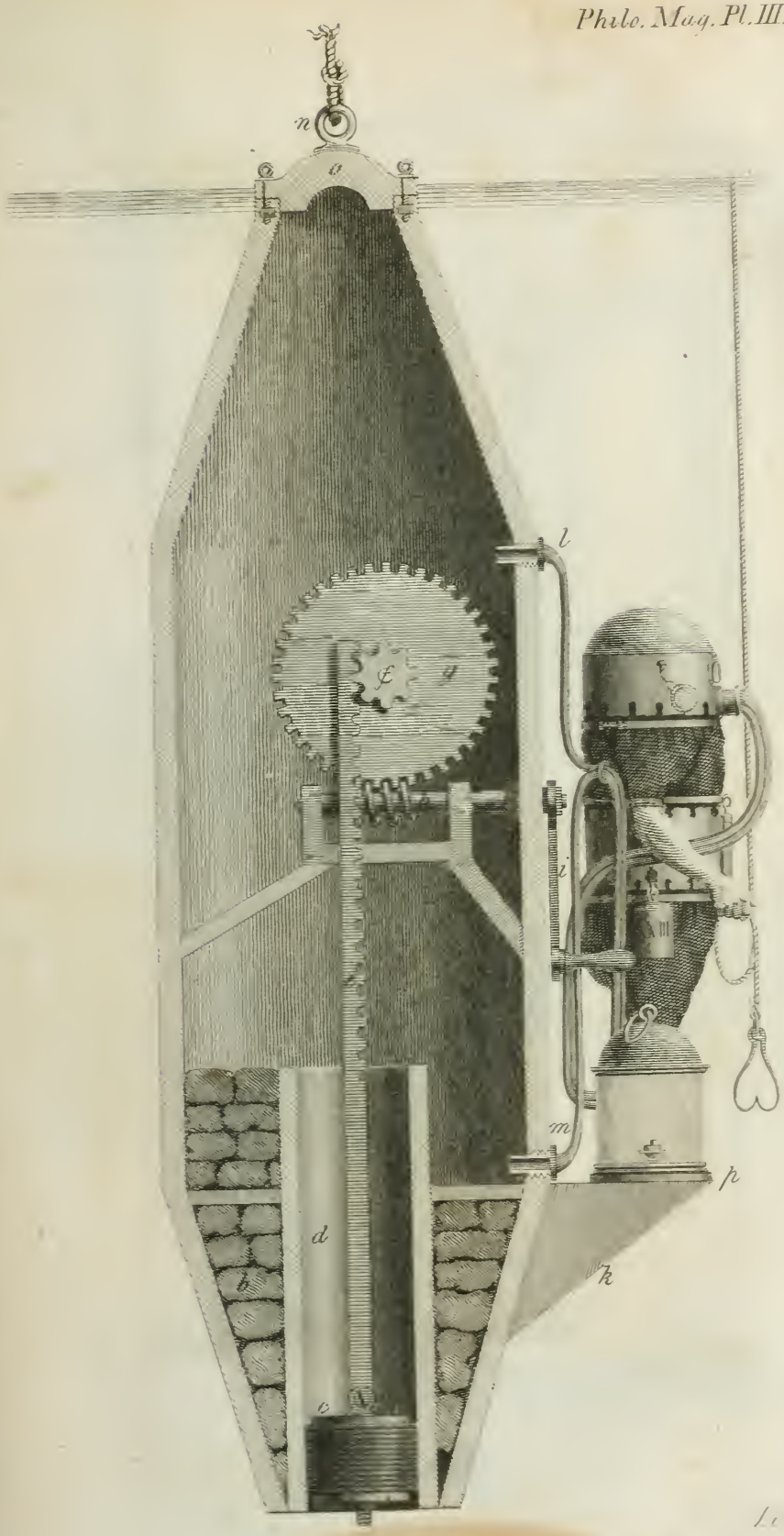

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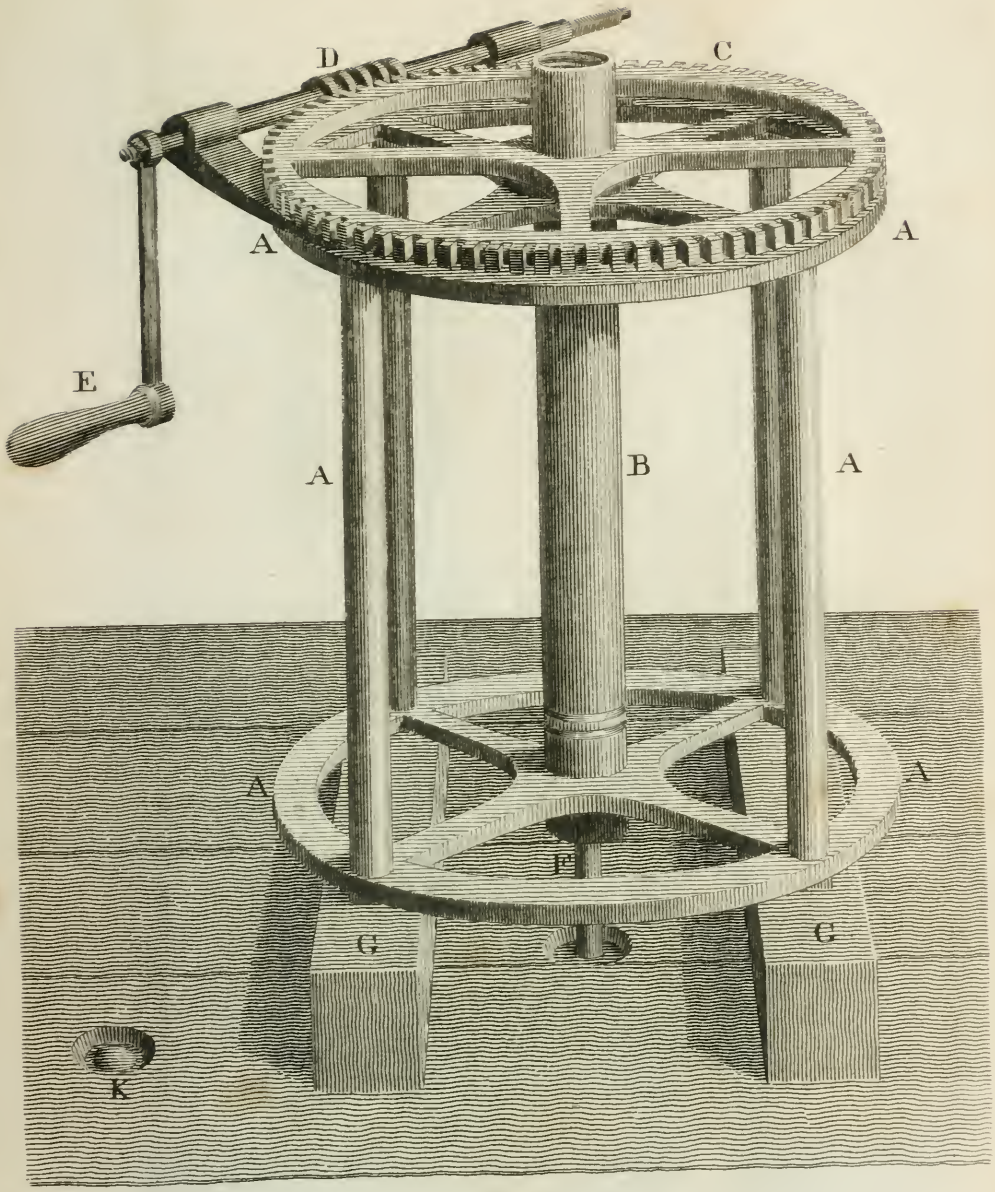

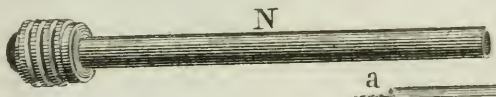

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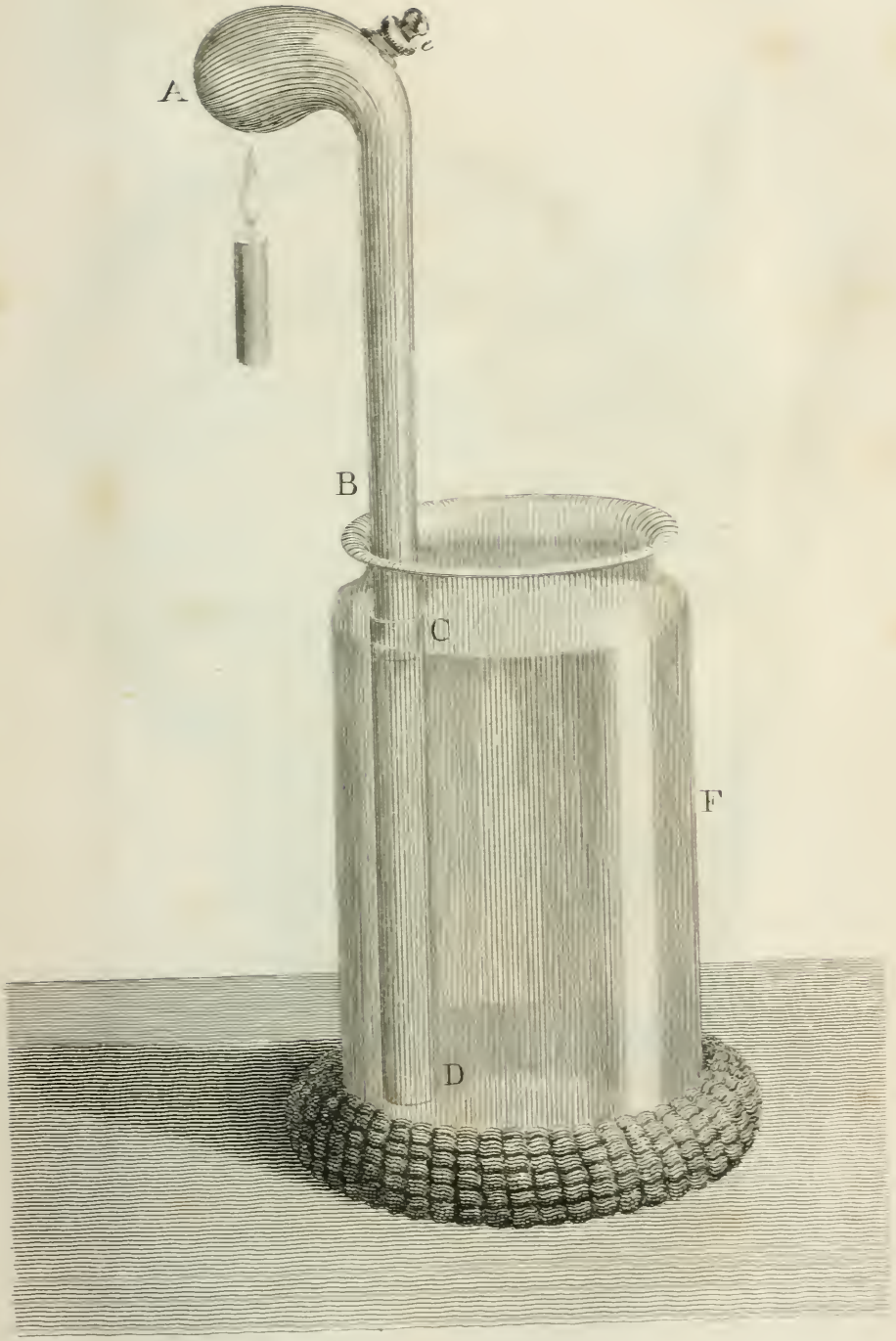
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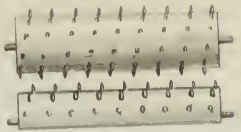

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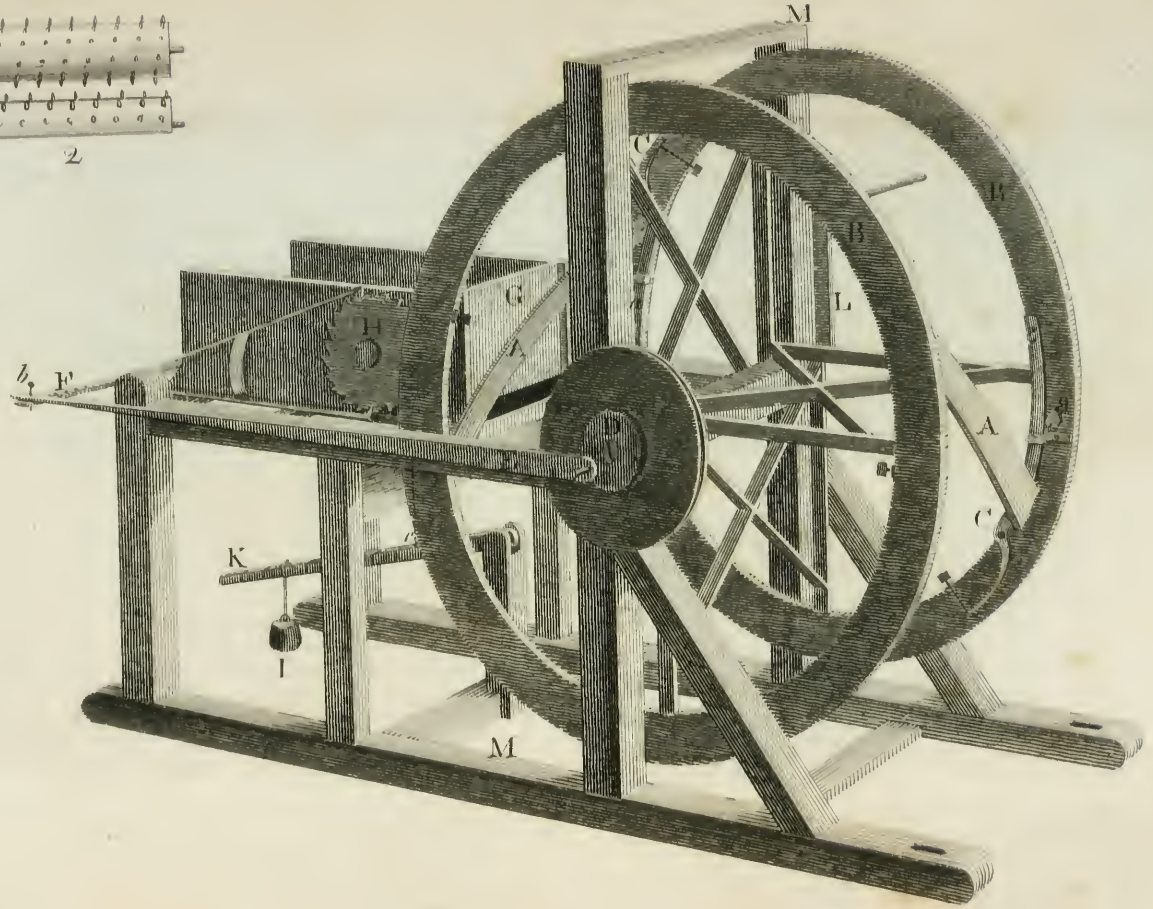

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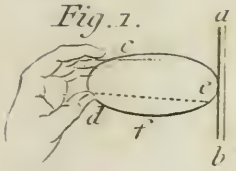

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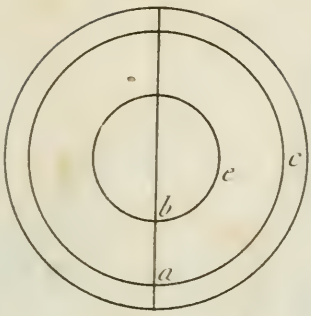

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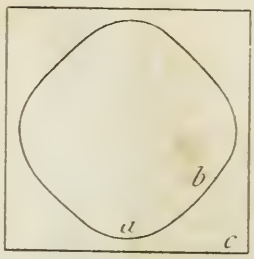

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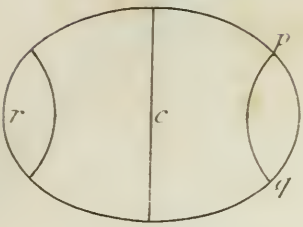

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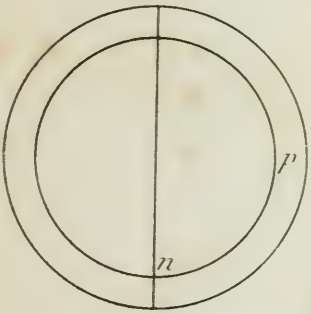

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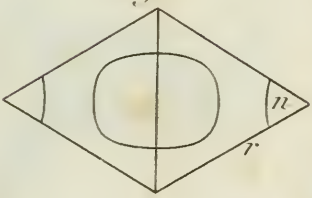

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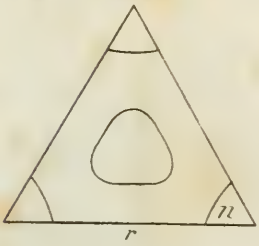

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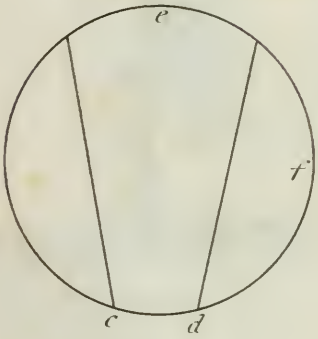

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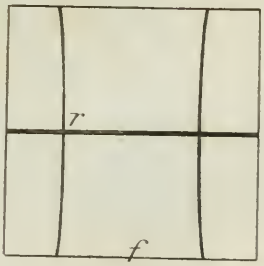

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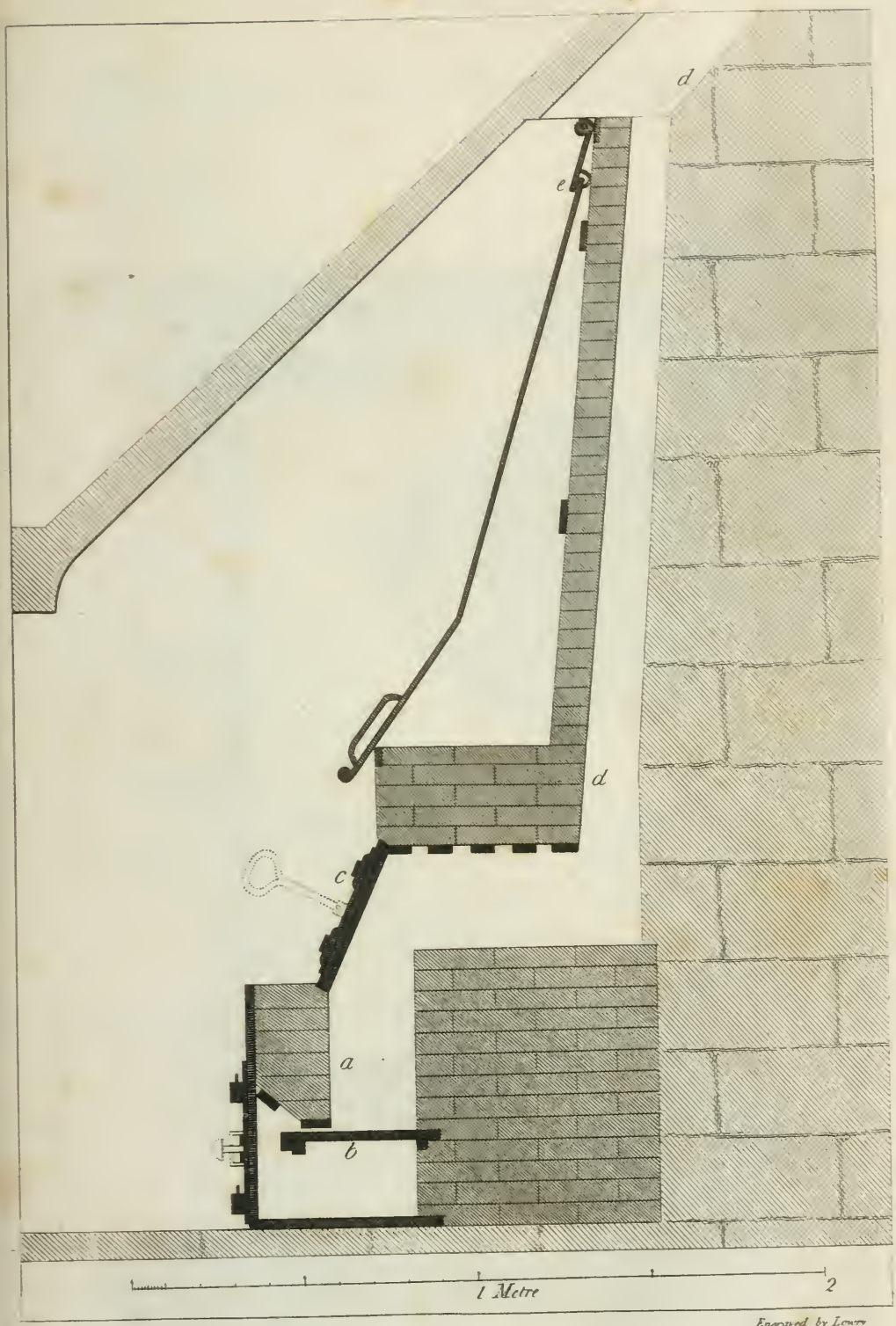

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ERRATA.

Page 15, l. 24, for *craters* read *crater.*——P. 22, l. 22, for *carb.* 3·65, read *carb.* 3·615.——P. 23, l. 15, after *elegances,* add *of life.*——P. 25, l. 20, for *Lancaſhire,* read *Lanarkſhire.*——P. 25, l. 16, after *aſſay,* inſert *furnace.*——P. 28, l. 9, for *formed,* read *found.*——P. 29, l. 6, read, accompanying *ſebiſte* and rubbiſh.

The Binder is deſired to notice, That the Plates in No. XI. for April, are wrong numbered in ſome Copies. Plate VII. ought to be Plate VI. and the Quarto Plate marked VIII. ſhould be Plate VII.

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